SCIENCE

VOL. LXXIII FRIDAY, JANUARY 23, 1931 No. 1882

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SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

EROSION AS A FACTOR IN SOIL DETERMINATION[1]

By M. F. MILLER

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IT is common knowledge that soils may deteriorate more or less seriously under agriculture. The fundamental changes accompanying this deterioration may include such alterations as a decline in the original store of organic matter, a decrease in the amounts of total and readily available nutrients, an increase in the hydrogen-ion concentration, a modification of the biological activities, and a change in the physical properties of the soil. The extent to which erosion is responsible for such changes has been the subject of much recent speculation. Simple observation warrants the statement that under favorable conditions for erosive action, erosion may be the principal contributing factor responsible for such deterioration, while under less favorable conditions its importance may be of minor significance. There is little doubt, however, that taking the agricultural regions of the United States as a whole far too little consideration has been given to this matter.

Erosion through the action of wind or water is a natural phenomenon with which most people are familiar. The development of the existing topographic relief in any given section of the country is to a large degree the result of erosive action. It, therefore, has a great geological importance in determining the character of land surfaces. But erosion is also of importance in determining the character of both virgin and cultivated soils, and as a consequence it has a great significance to agriculture. Under nature, soil removal through erosion takes place slowly, but under agriculture, particularly a type of agriculture which makes no provision for soil preservation, such losses may be tremendously magnified.

Wind erosion, which is confined largely to semi-arid and arid regions, may under systems of grain farming

[1] Address of the retiring chairman and vice-president of Section O—Agriculture, American Association for the Advancement of Science, Cleveland, Ohio, December, 1930.

bring about great damage to crops and a degree of soil injury which sometimes results in land abandonment. Serious water erosion may also occur in semi-arid regions, although its influence is naturally most wide-spread in the humid and sub-humid sections. The discussion which follows will be confined to water erosion, particularly that of humid and sub-humid regions and largely to that of lands devoted to agriculture.

Water erosion is commonly considered as of two types, sheet erosion and gullying. Sheet erosion is that through which the soil of the immediate surface layers is removed through the flooding of heavy rains. It is this type of erosion which, under agriculture, is responsible for the largest soil losses, particularly where land is plowed and left bare for considerable lengths of time or where it is planted to intertilled crops, such as corn or cotton. Gully erosion, on the other hand, through which the soil is trenched and scarred by the action of run-off water, may occur on grass lands as well as lands under cultivation. The final effect of serious gully erosion is to cut the fields into such small tracts that a profitable agriculture, through the use of ordinary farm implements, becomes practically impossible.

The factors which determine the rate of determination of agricultural lands through erosion are; First, the amount, distribution and the torrential character of the precipitation; second, the number of days of the year when the soil is not frozen; third, the topography; fourth, the character of the soil; and fifth, the system of agriculture. Generally speaking, erosion is most severe where a large percentage of the rains are of torrential character, where the ground is frozen but a small portion of the year, if at all, where the land slopes are steep, where the soil texture is such as to be easily eroded, and where the system of agriculture is one which exposes much of the bare soil surface to surface run-off.

Observations of the losses due to the erosion of agricultural lands show these to be greatest in the soils of the Southern states, particularly those of the southern parts of the Appalachian and Piedmont regions, of the Atlantic coastal plain, of parts of the limestone regions of Kentucky and Tennessee, of the black soil belt of Texas, and of the southern parts of the corn belt. Serious losses are also taking place in parts of the range country of the West, where close pasturing has exposed the soil to the action of the torrential rains of those regions.

Trustworthy estimates of the erosion losses taking place from farm lands are difficult to make. A careful observer traveling through those areas most subject to serious erosion is struck by the tremendous damage that has resulted. Bennett states[2] that in a single county in the Southern Piedmont Region 90,000 acres of land have been permanently ruined by erosion, and 70,000 acres in another, while in many other Southern counties such ruined lands represent areas ranging from 10,000 to 30,000 acres, most of which was once under cultivation. Areas have been examined in these counties where ten or more inches of soil have been removed during 30 years of agriculture. Naturally such losses represent extreme cases rather than the average. There is no doubt, however, that over the southern half of the humid region of the United States and over a part of the northern half, erosion losses are very severe. Moreover, the damage is undoubtedly cumulative, increasing somewhat as the absorptive power of the soil for water decreases, due both to a decrease in the supply of organic matter and to a decrease in the depth of the absorptive surface layer.

Exact measurements of the erosion losses which may take place under agriculture have thus far been made in only a few places. The studies which have been made at the Missouri, North Carolina and Texas experiment stations have furnished the major part of such data. The climate, soils and systems of cropping at these three stations vary widely, as do the amounts of soil eroded under the different crops and cropping systems, yet the data give some idea of what may be expected in widely separated sections of the country.

At the Missouri station the studies have been confined largely to a Shelby loam soil with a grade of 3.68 per cent., a length of slope of 90 feet, and under a rainfall of approximately 37 inches. As an average of twelve years' measurements bare, uncropped and cultivated land has suffered an annual loss of approximately 43 tons of soil per acre. Under exactly the same conditions land cropped continuously to corn has lost approximately 20 tons per acre annually, that in continuous wheat 9 tons, that in a good crop rotation 3 tons, while land left in continuous sod lost soil at the rate of only one third of a ton annually. Under these conditions of the surface 7 inches of soil would be removed from the uncropped, cultivated land in 23 years, from the corn land in 50 years, from the wheat land in approximately 100 years, from the land in a good crop rotation in 350 years, while under sod almost 3,000 years would be required. These figures show the very great influence of the system of agriculture, particularly the cropping system, on erosion losses. Certainly the grade of 3.68 per cent. is not greater than an average for corn

[2] U. S. Department of Agriculture Circular 33.

belt soils and these data give a good idea as to what may be expected under these conditions.

Data similar to those just given are available from these same studies, showing the influence of different grades on erosion losses. As a four-year average and where the same years are compared, land in continuous corn, with a grade of 3.68 per cent., lost soil at the rate of 26 tons per acre annually. With a grade of 6 per cent. the annual acre loss was approximately 85 tons, and with a grade of 8.5 per cent. the loss was approximately 150 tons. Under the 8.5 per cent. grade on this Shelby loam soil, when planted continuously to corn, the surface soil was removed at the rate of one inch per year. The normal depth of the surface soil is approximately 9 inches so that under such conditions the subsoil would be exposed in less than one decade. It is under such conditions that sheet erosion becomes very destructive in removing the fertility which nature has taken thousands of years to accumulate in this humus-bearing layer of surface soil.

Many estimates have been made of the amounts of plant nutrients removed from the land through erosion. Some of these estimates are based on careful determinations of the elements carried in river water. An example of such an estimate is that of McHargue and Peter[3] who analyzed the material carried in solution by the Mississippi River at Baton Rouge, and calculated the annual loss from the Mississippi basin to be approximately 630,000 tons of nitrogen, 62,000 tons of phosphorus, 1,626,000 tons of potassium, and 22,446,000 tons of calcium. This, of course, does not include the nutrients carried to the Gulf in the suspended material or deposited along the course of the Mississippi and its tributaries. On the other hand, much of the mineral nutrients, particularly the lime, was probably derived from rock rather than from the soil. It is, therefore, unlikely that such estimates represent very closely the actual losses from agricultural lands.

The erosion measurements at the Missouri station include some data as to the elements contained in the eroded material. These data show an annual acre loss from the 3.68 per cent. grade under continuous corn of about 65 pounds of nitrogen, 18 pounds of phosphorus and 610 pounds of potassium. Continuous wheat allows a loss of about 30 pounds of nitrogen, 9 pounds of phosphorus and 250 pounds of potassium. Under the corn, wheat, clover rotation, however, the losses are reduced to about 18 pounds of nitrogen, 4 pounds of phosphorus and 140 pounds of potassium, while under continuous sod they reach the extremely small quantities of less than a pound of nitrogen and phosphorus, and only 4 pounds of potassium. These figures represent a single soil under southern corn belt conditions and for a short period of measurement only, yet they give a good comparison of the influences of different crops and a good crop rotation on the losses which may take place.

It will be observed that the losses of nutrient elements through erosion, as compared with the losses through crops in these Missouri studies of a loam soil of 3.68 per cent. grade, depend largely on the cropping system. Under a poor cropping system of continuous grain farming the losses from the two sources, with the exception of the potassium, are about equal, but under a good cropping system the erosion losses are much less than the losses through crops. However, when land with a grade of 8.5 per cent. was studied the erosion losses were multiplied several times. It can be said, therefore, that with a moderate grade and a good cropping system in the southern corn belt, losses of soil nutrients through erosion do not compare with the losses through crops, but with steeper slopes and especially under excessive corn farming, these losses may be several times those through the crops.

The erosion measurements at the North Carolina station have been carried out on a Cecil fine sandy loam soil with a grade of 9 per cent., a length of slope of 75 feet and an average rainfall of 41 inches. A three-year average shows an annual acre loss from cultivated uncropped land of approximately 21 tons, from continuous cotton 20 tons, from continuous corn 13½ tons, and from continuous sod only .42 ton. These losses, even on a grade of 9 per cent., are somewhat less for cultivated uncropped land and for continuous corn land than from the grade of 3.68 per cent. at the Missouri station, thus emphasizing the great differences which may be expected from different soils and different types of rainfall. Both sets of measurements show great losses of soil under the constant production of intertilled crops as compared with sod. The North Carolina measurements show a somewhat less loss of nitrogen, a greater loss of phosphorus and a much greater loss of potassium through the eroded material than through the continuous crops of corn and cotton.

At the erosion experiment farm at Spur, Texas, measurements have been made on the Miles clay loam having a grade of 1 to 3 per cent., a length of slope of 96 feet and an average rainfall of 27 inches. With a grade of 2 per cent. the annual acre loss for three years has been: from cultivated uncropped land 18.6 tons, from continuous cotton 12.6 tons, from continuous Milo maize 5.7 tons, and from continuous Buffalo grass sod 3.8 tons. As compared with those

[3] Kentucky Experiment Station Bulletin 237.

on the 9 per cent. slope in North Carolina these losses on this 2 per cent. slope are remarkably high, showing again the marked variations to be expected under varying conditions of soil and precipitation.

Careful estimates of the soil lost from individual farms have been made in only a few instances. At the erosion experiment farm in northern Missouri, a careful determination of the depth of the soil at 100-foot intervals over the 220-acre tract shows erosion losses, as compared with similar uneroded land, varying from less than an inch to more than 12 inches. Naturally, the 12-inch losses are confined to the steeper grades and the small losses to the more level areas. When these losses are applied to the whole 220 acres, the average loss is almost exactly one inch. Since the average depth of soil is around 10 inches, approximately one tenth of the surface soil has been removed since the land was put into cultivation, or in about 50 years. This land has been handled largely as a livestock farm, and the cropping system has included a good deal of grass so that the erosion has not been excessive. The rate of one inch in 50 years or seven inches in 350 years is identical with that of the corn, wheat, clover rotation on the 3.68 per cent. grade in the Missouri measurements which is probably not far from the average corn belt loss under a good system of cropping. It is, however, from the steeper than average grades and under poor systems of soil preservation that the serious losses occur.

It is quite evident, from the data available, that the erosion factor in soil deterioration is a very significant one, although its importance varies greatly with conditions. Under nature the advancing stages of early erosion may remove good virgin soils which may later be replaced by much poorer ones, yet it is under agriculture that the most rapid changes take place. Under the most favorable conditions for erosion a type of agriculture poorly adapted to soil preservation may allow the entire surface soil to be removed within a generation, or in the case of the very steep grades within a decade.

The relation of climate to the rate of erosion losses is very significant. Generally speaking, erosion losses are low in the cooler climates where the surface is frozen for several months of the year and they are higher in the warm climates. They are high where the precipitation is 20 inches or more and where there are many rains of torrential character. Erosion losses are, therefore, low in the northern part of the United States and in most of northern Europe, since both the temperature and the character of the rainfall are such as to prevent excessive soil removal. These losses are highest where a temperate or subtropical climate leaves the soil unfrozen almost the entire year, and where torrential rains occur during the growing season when the soil is being cultivated. The greatest losses during a given season will occur when a torrential rain falls on bare, cultivated land already filled with the water of a previous rain.

The relation of soil character to erosion losses is not well understood. Middleton[4] has shown that the most important single factor governing the case of erosion of a soil mass is the so-called dispersion ratio, which refers to the proportion of the silt and clay easily dispersed in water. General observations show that as a rule soils having a medium texture of the surface soil (A horizon) such as silt loams, loams and fine sandy loams, suffer most, particularly from sheet erosion, and that such losses decrease as the texture approaches either extreme. If such surface soils are underlaid with a tight clay subsoil (B horizon) the losses from sheet erosion are intensified. While small gullies form readily in soils of medium texture with tight subsoils, deep gullies are developed most rapidly when such surface soils are underlaid by loose silt loam, sandy or sandy loam subsoil. If the deeper soil material is also made up of loose silt or sandy loam, such as is characteristic of some of the loess deposits, uncontrolled gullies may assume frightful proportions. The most marked examples of this in the United States are in the belts of loessial soils lying on the east side of the Mississippi from the Ohio River southward.

In contrast to soils which are very susceptible to erosion there is evidence that some of the lateritic soils of the tropics do not erode seriously even under very excessive amounts of precipitation. It has been suggested that this is associated with the high silica and low sesquioxide content of these soils. Bennett reports that certain lateritic clays of Porto Rico and Cuba remain so porous and friable, even under cultivation, that they absorb great quantities of water and erode very little. Such soils differ greatly from the easily eroded soils of the southern part of the great group of podsolic soils of the United States.

The general relation of the percentage of grade to erosion losses is too well known to need particular comment. However, no exact mathematical expression of this relation with different soil textures is yet available. Because of the influence of such factors as soil granulation, the tightness of the subsoil, and the nature of the rainfall, mathematical relationships are very difficult to establish. Under most conditions land having a grade of over 10 per cent. must be handled with great care to prevent serious loss and under these natural conditions most favorable for

[4] U. S. Department of Agriculture Technical Bulletin 178.

erosion land with a slope of only 2 or 3 per cent. must be given particular attention to avoid excessive damage.

The relation of systems of farming to erosion losses has a very practical significance. When it is considered that bare or cultivated land suffers most and that such losses are largely overcome by the use of sod crops and greatly decreased by the use of small grain crops, the influence of the cropping system is at once apparent. The large acreages of corn in the corn belt and of cotton in the cotton belt are principally responsible for the excessive erosion losses which have taken place in those regions. Coupled with this has been the failure of the average farmer to realize the importance of such losses and as a result he has given little attention to the control measures which lie within his reach. Too often he has allowed sheet washing to proceed and gullies to go uncontrolled until whole farms and groups of farms have reached the stage of abandonment. The farmer should not receive too much blame for this, however, as corn and cotton are the principal money crops in these regions and he is human.

In summation it can be said that in considerable areas of the United States as well as of other countries, where the climate is temperate to subtropical, where other natural conditions are favorable to erosion, and where the systems of agriculture include large acreages of intertilled crops, the erosion factor is by far the most important one in bringing about serious soil deterioration. However, on the great majority of the farms in the corn and wheat belts and on many farms in the cotton belt, the losses are moderate. In some cases, such as very level lands, the losses are negligible. In fact, in the case of very level uplands the erosion losses may be too slow for the good of the land. It must be understood that a limited amount of erosion is beneficial. It is a rejuvenating process. In case of the very level virgin uplands of the humid regions the run-off and erosion are so small that these soils may become badly leached and low in basic material, while at the same time they may develop very tight subsoils with a resulting decrease in natural fertility and in productivity. The most productive virgin upland soils are those which are sufficiently rolling that the surface drainage is ample and from which sufficient erosion takes place that new layers of soil material are constantly, even if very slowly, brought within the action of surface weathering agencies and root penetration. Such soils are not excessively leached and they are not underlaid by excessively tight subsoils. Moreover, if systems of cropping and other means of erosion control are adopted for their proper preservation, these soils remain most productive under agriculture. However, in those regions where natural conditions favor erosion it is rather difficult, even with slight grades, to limit erosion losses to a point that is negligible. If the Missouri figures may be taken to represent southern corn belt conditions, a loss of one inch in 50 years from a moderate grade and under a good cropping system may be expected. Such a loss is not great and it seems quite evident that under proper systems of soil management in this region the average erosion may be reduced to a factor of no great importance. Moreover, in the northern part of the corn belt the conditions for erosion are less favorable, and while no accurate data are available, the losses must be less. It must be remembered, however, that in the corn belt as a whole only a small percentage of the farmers follow a system of farming which is most effective in limiting erosion losses. As a consequence in the rich loose silty soils of the southern and central corn belt, particularly where the topography is rolling to steep, erosion losses are taking place at a rate which allows erosion to rank first among the factors that lessen soil productivity.

Little accurate data are available from which to judge the rate at which weathering agencies will replace the surface layer of soil under erosion losses, but it is generally thought to be very slow. Of course, when the depth of the surface soil has been reduced to 6 or 7 inches the action of the plow in bringing layers of the subsurface soil into the plowed zone and the incorporation of organic matter with it tends to maintain a surface soil layer of plow depth. Moreover, there are experimental data, as well as practical information, which show that through the use of legumes or the incorporation of organic matter, along with the use of lime and fertilizers, raw subsoils may be made to produce good yields of crops. Naturally such a system necessitates considerable expense, particularly in the early years of its use, but where crops of rather high unit value can be produced such systems may be quite profitable. However, such soil rejuvenating systems are never likely to be as profitable as those in which the natural surface soil is preserved. It is highly important, therefore, that the farmers of the corn belt, as well as those of the cotton belt, be encouraged not only to follow systems of farming which minimize erosion losses but to put into practice wherever necessary those mechanical means of erosion control which have been shown to be effective, such as the use of terraces, soil saving dams and contour farming. It is the duty of the federal and state agencies dealing with agriculture to give special consideration to the erosion losses that are taking place and to encourage the general adoption of practical measures of control.

OBSERVATIONS UPON THE USE OF THE DIVINING ROD IN GERMANY

By Dr. C. A. BROWNE

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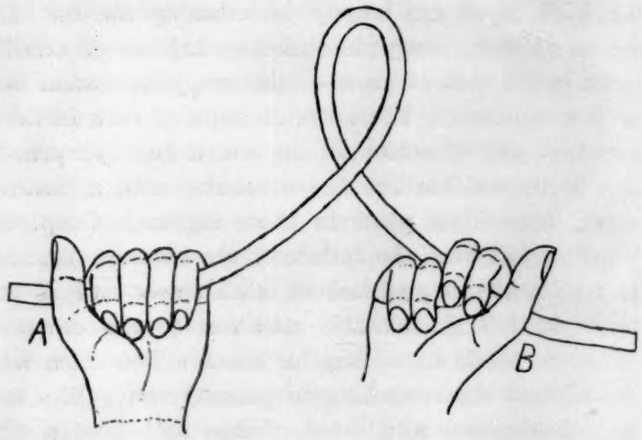
THE use of the divining rod, as a means for discovering subterranean supplies of water and metals, is usually dismissed with alchemy, astrology, table tipping and other occult sciences as a subject unworthy of serious consideration. The numerous books and articles upon rod operating which appear from year to year indicate, however, that the subject is one of constant and ever-increasing interest. During a recent extensive agricultural tour in various countries of Europe I was surprised to learn of the frequency with which the divining rod is employed to locate sources of water for estates, industries, towns, railroads, hospitals and other institutions. The recent statement of Professor J. W. Gregory that this repudiated instrument "is perhaps more used now than at any previous time" is in my opinion no exaggeration.

While visiting a large sugar beet estate near Magdeburg, Germany, last June, I was informed that its water supply had been located by a celebrated professional *Rutengänger* (rod walker), or dowser, and on July 6 I availed myself of an opportunity to observe this operator's method of working. He has acquired great notoriety in Germany for his success in finding subterranean water supplies, a publicity that has been enhanced by his numerous articles upon the subject. His published lists of references include several thousand names of estate-owners, factory officials, managers, contractors, etc., who all speak highly of his success in locating water supplies for their special needs. As this operator's method of using the rod and his views upon the subject differ so considerably from the accounts given in the literature upon water-divining the following account may be of interest.

A demonstration was given before a small private audience in a vacant lot in the suburbs of Magdeburg. The operator carried with him several loop-shaped rods of about the little finger's thickness (see cut) of steel, aluminum and other metals, the choice of the rod depending upon the nature of the test. Before beginning operations he fastened to his chest a padded leather jacket to protect himself against the blows of the implement. Selecting first a steel rod and grasping it with one end in each hand, palms upward (the left as at A and the right as at B), elbows against sides and the loop extended horizontally before him, he began to pace across the lot when sud-



denly the loop of the rod shot upward and struck the leather chest-protector a strong blow. The spot where this occurred, according to the operator, marked the edge of a subterranean stream. By continuing the survey in other directions the boundaries of this reputed stream were located. From the demarcations of the reactive zone obtained by another rod of aluminum (stated to be of greater sensibility) the depth of this stream was estimated and by observing the reaction with another rod the operator pronounced the water to be sweet; he also indicated the direction of the underground stream. He stated that with certain metallic ores the rod struck downwards while in the case of petroleum a vibratory movement of the rod took place. The operator made the curious statement that spots which lie above the intersection of subterranean water veins are particularly reactive and hence exposed to the danger of being struck by lightning. He stated that one end of the rod was positive and the other negative and that he could form conclusions as to the nature of underground deposits of coal, potash, petroleum, metallic ores, natural gas and other substances by comparing the reactions of his different rods first with the positive pole in the right and the negative in the left hand and then with these positions reversed. The technique of dowsing would thus seem to be more highly elaborated in Germany than in other countries.

When I attempted to use the rod myself no reaction was obtained. But when I grasped one end tightly with both hands side by side and the operator held the other end between the first two fingers and thumb of his right hand (as at B), and extended his left hand to within a few inches of my shoulder, the rod twisted strongly upward, as we came to the reactive

zone, notwithstanding all my efforts to prevent this by tightening the grasp of my hands. The same effect occurred when a third person, touching my arm, stood between me and the operator, who explained that had he actually touched us during this experiment the rod would have given me a serious blow because of the greater intensity of the reaction. The experiment of interposing another person in the circuit of rod and operator is frequently performed by dowsers and is held by many to prove that the motion of the rod is due to an external force. Barrett and Besterman in their book upon "The Divining Rod" (1926) describe many such experiments and come to the conclusion that it is a muscular action of the dowser that moves the rod. While it would seem impossible for a person to move the rod with only two fingers and a thumb in opposition to the efforts of two hands, I nevertheless believe that with the rod held as in position B, the muscular fingers of an experienced operator can secure a sufficiently strong grip upon the polished metal to move it against the combined resistance of two hands held side by side as at A. The rod in this case would function simply as a crank with the two hands at A serving as the bearings. It was noticed that the operator always held his right hand nearer to the loop of the rod and this would be the better position for producing a crank motion. The operator declared that there was no trick in the matter and that the rod moved without conscious effort upon his part.

When asked for an explanation of the force that moved the rod the operator replied that he could only offer a conjecture. It was his opinion that emanations of different highly penetrative rays were constantly escaping from the interior of the earth through the outer crust into space. These rays he thought to be absorbed in whole or in part by deposits of water, potash, coal, petroleum, minerals and other substances, with the production of surface areas more or less devoid of certain emanations. He compared these rayless zones with the shadows cast by the globe of a lamp upon the ceiling and supposed them to affect the sympathetic nervous system of his body in such a way that unconscious muscular contractions produced the movement of the rod. When asked if these so-called rayless areas could not be detected by physical methods he replied that Dr. Ambronn and others had devised electrical apparatus for locating hidden supplies of water and minerals, but nothing had yet been found so delicate as the human body. He claimed to have demonstrated the projection of these reactive rayless zones into space by making experiments with his rods in an airplane!

The operator stated that "rod-walking" was very exhausting, that his pulse rate went up to 140 beats per minute and that three hours per day was as long as he could operate without danger of collapse. He was of the opinion that his dowsing ability was the result of a tropical fever which left him with a supersensitive nervous system. His palms and fingers were calloused from frequent use of the rod. An inflamed appearance of the skin of his palms he attributed to burns produced by radiations at the positive and negative poles of the rod. Many of his statements were, in fact, a confused jargon about alpha and beta rays and other terms picked up from his loose reading of scientific books.

But apart from the absurdities and inconsistencies of his explanations, which after all were only conjectures, and disregarding the sensational claptrap of many features of his demonstration this operator has to his credit an unusually long list of undisputed successes. A prominent well-driller in Magdeburg informed me that he was correct in his predictions in over 90 per cent. of the cases, his failures being usually errors in estimating either the amount or the depth of the hidden water supply.

The opinion of several German scientists, whom I questioned regarding the reliability of dowsing as a method of locating water, was that after excluding the inevitable humbuggery and deception which attend so many performances of this kind there still remains the large residuum of successes, achieved by certain rod-operators, that could not be attributed to mere chance or luck. They thought it possible that these men might, perhaps, have inherited some primitive racial sense, not shared by other men, like the homing instinct of pigeons or migratory birds; or else that they might be gifted with an exceedingly acute unconscious power, sharpened by a wide prospecting experience, of rapidly correlating certain peculiarities of topography with the occurrence of subterranean water pockets. The former view is essentially the cryptesthetic theory of dowsing proposed by Barrett and Besterman in their book upon "The Divining Rod"; the other view of sharp observational ability is the one suggested by Gregory in his paper before the British Waterworks Association in 1927 upon "Water Divining"[1] in which he subjects the cases of Mullins, Stone and other operators, described by Barrett and Besterman, to a critical review. Whichever of these explanations be adopted, the rod itself is ruled out of consideration as a primary cause of the phenomenon. In fact several noted water-finders, as the celebrated Abbé Paramelle of France,

[1] Reprinted in Annual Report of the Smithsonian Institution, 1928, p. 325.

and Gataker in England, have made no use of a rod at all. This implement would therefore appear to serve only as a helpful index for expressing certain states of the dowser's subconsciousness. What impressed me as peculiar in the Magdeburg demonstration was that the operator employed a heavy metallic rod instead of the traditional and more easily manipulated fork-shaped branch of a tree.

The explanation of an external physical force, as suggested by the German rod-walker, has nevertheless a large number of advocates, the best known of whom is, perhaps, Henri Mager, of France, whose views have been rejected by Barrett and Besterman and also by Gregory. This opinion has recently been revived again in a lecture before the Czecho-Slovakian Academy of Agriculture by R. Janota[2] who compares the body of the dowser to a wireless receiving set, the hands acting as the two electric poles, the legs as the earth line and the rod as the antenna. This lecturer states that just as some wireless receivers have certain defects so the human nervous systems of different individuals are not equally sensitive.

The Czecho-Slovakian Academy of Agriculture appointed a committee to investigate the phenomenon. Similar committees have been appointed in fact in many European countries but with unsatisfactory results. As Gregory has pointed out, "Testing the divining rod is difficult and promises no answer that will be universally accepted." Following the negative results reported in one test come the favorable results reported in another, as for example in the recent experiments at Johannesburg, where the celebrated English operator Stone, who used a clock spring for a rod, was reported to have been successful in finding hidden bags of gold.

With the growing population of Europe there has been a constantly increasing need of new supplies of water for agricultural, industrial and municipal purposes and this want is reflected in the increasing number of dowsers, *sourciers* and *Rutengänger* who are ready to supply the demand for their services. Even those who scoff at the rod as a relic of superstition do not hesitate to employ it should the occasion arise. In this respect they are following the attitude of Sir Herbert Maxwell, who once remarked, "I don't believe in the divining rod, but I don't deny that its virtues are genuine; and were I in straits to find water, I should employ without hesitation a professional water finder—rod and all—if there remains one so successful as Mullins was."[3]

OBITUARY

JUR. PHILIPTSCHENKO

JUR. PHILIPTSCHENKO, professor of genetics, died of meningitis on May 19, 1930, at Leningrad. He was born on February 1, 1882, in the family of an agriculturist-scientist residing in the province of Orel. After graduating at the University of Petersburg, in 1906, he continued studying for his professorship at the Zoological Cabinet of the university. In 1912 he presented his dissertation on the embryology of Apterygota, and the degree of master of zoology was conferred on him for it. In 1917 Jur. Philiptschenko obtained his doctorate on presenting another dissertation on the variability and heredity of the skull in mammals. In the meanwhile, he was elected first assistant professor, then reader in zoology, and in 1919 professor of the University of Petersburg, where he established the first chair of genetics in Russia and founded a new school of young geneticists. Besides his work at the university he gave lectures at several other superior schools. Since 1920 Professor Philiptschenko was in charge of the laboratory of genetics and experimental zoology in the Institute for Research in Natural Sciences at Peterhof. In 1921 he became chief of the bureau of eugenics and genetics at the Academy of Sciences. Some months before his demise Professor Jur. Philiptschenko was placed at the head of the department of genetics of the Institute of Animal Industry of the Lenin Academy of Agricultural Sciences in U. S. S. R.

His works, nine of which represent large manuals of genetics and experimental zoology, amount to 114 in number.

The publications of the earlier period of Professor Philiptschenko's scientific work (1905–1913) supply valuable data pertaining to the domain of anatomy and embryology of Apterygota; those of the later part (1914–1930) furnish important facts relating to genetics of animals and plants.

Professor Philiptschenko devoted the last seven years of his life to the study of the variability and heredity of quantitative characters in soft wheats, as well as of the process of development of the ear in wheat. Five of his works on these subjects were published in Germany, and a monograph by him on the genetics of soft wheats is being issued.

Professor Philiptschenko was a member of several Russian and foreign scientific societies as: Deutsche Gesellschaft für Vererbungswissenschaft, the Amer-

[2] Bulletin of the Czecho-Slovakian Academy of Agriculture, Vol. VI, No. 2, pp. 190–197, with report of discussion, *ibid.*, pp. 198–202. See also abstract, *Internat. Review of Agriculture*, Monthly Bulletin of Agricultural Science, May, 1930, p. 162.

[3] "Memoirs of the Months," I, 103–106: (1897).

ican Genetic Association, Deutsche Gesellschaft für Züchtungskunde, Société de morphologie de Paris, etc.

As to his personality, it should be mentioned that he was not only an eminent scientific investigator and a brilliant lecturer, but also an exceptional man, well known for his inexhaustible energy, kindness and responsiveness to the needs of all those who surrounded him. His death was a heavy blow to every one who knew him closely and a great loss for science.

M. RIMSKY-KORSAKOW
V. DOGIEL
M. ROZANOVA
T. LUS
T. LIEPIN

MEMORIALS

A MEMORIAL meeting in honor of the late Dr. Henry Leffmann was held in the auditorium of the Wagner Free Institute of Science on January 16, with addresses by Dr. Wilmer Krusen, president of the Philadelphia College of Pharmacy and Science; Dr. Howard McClenahan, president of the Franklin Institute, and Dr. Samuel T. Wagner, Jr., treasurer of the Wagner Free Institute of Science.

AN oil painting of Graham Bell, by Mr. W. W. Russell, R.A., was presented to the British Institution of Electrical Engineers by Sir Hugo Hirst on January 8.

THE council of the senate of the University of Cambridge has appointed the following committee to arrange for the celebration of the centenary of James Clerk Maxwell: The Vice-Chancellor, Sir J. J. Thomson; Mr. W. Spens, master of Corpus Christi College; Sir Joseph Larmor, Sir Ernest Rutherford, Dr. C. D. Broad, Professor H. F. Newall, Sir Arthur Eddington, Professor C. T. R. Wilson, Professor F. J. M. Stratton, Dr. J. Chadwick, Dr. J. D. Cockcroft, and Sir James Jeans.

THE centenary of the birth of the celebrated syphilologist Alfred Fournier will be celebrated on May 12, 1932, under the presidency of Dr. Lucien Hudelo, president of honor of the French Society of Dermatology and Syphiligraphy. Further information can be obtained from the general secretary, Dr. Sicard de Plauzoles, 44, Rue de Lisbonne, Paris, VIII^e.

ON the occasion of the opening of the Pasteur pavilion of the Instituto Bacteriológico of the National Department of Hygiene of Buenos Aires, which pavilion is devoted to studies of plague and mycology, a plaque was unveiled in honor of Pasteur. The president and ministers of the government of Argentina and representatives of the principal medical societies were present. The diplomatic representative of France, and Drs. C. Nicole, G. Araoz Alfaro and Ponce de Leon, made addresses.

RECENT DEATHS

DR. W. A. LIPPINCOTT, professor of poultry husbandry at the University of California since 1923, has died at the age of forty-nine years.

THE death at the age of fifty-six years is announced of Dr. Frederick J. Pritchard, senior plant physiologist of the U. S. Department of Agriculture.

EDGAR STEINER THOMSON, professor of ophthalmology at the Manhattan Post-Graduate School of Ophthalmology, Otology and Laryngology and at the New York Polyclinic Graduate Medical School from 1912 to 1917, has died at the age of fifty-nine years.

DR. WILLIAM A. JONES, professor of mental and nervous diseases for ten years, 1909 to 1919, at the University of Minnesota, and president of the State Board of Health from 1905 to 1917, has died at the age of seventy-one years.

DR. FELIX LÖHNIS, head of the laboratory of agricultural bacteriology at the University of Leipzig, has died at the age of fifty-seven years. Dr. Löhnis was in 1914 appointed soil bacteriologist in the U. S. Department of Agriculture and in 1923 was made senior bacteriologist in charge of the office of soil bacteriology investigations in the Bureau of Plant Industry. He resigned in 1925 to go to Leipzig.

Nature records the death of Mr. T. F. Bourdillon, formerly conservator of forests, Travancore, on December 19, aged eighty-one years, and of Professor Pierre Termier, inspector-general of mines and director of the service de la carte géologique, who was elected in 1909 a member of the Section of Mineralogy of the Paris Academy of Sciences, aged seventy-one years.

DR. A. O. THOMAS, professor of paleontology in the University of Iowa, died on January 13 at the age of fifty-four years.

SCIENTIFIC EVENTS

EXHIBITION OF THE PHYSICAL AND OPTICAL SOCIETIES IN LONDON

THE twenty-first annual exhibition of the Physical Society and the Optical Society was opened by Sir Arthur Eddington at the Imperial College of Science, South Kensington, on January 6. According to the account in the London *Times* the exhibition included a great variety of electrical, optical and other physical apparatus, much of it on view for the first time. The first evening discourse was delivered by Mr. E.

Lancaster-Jones on "Searching for Minerals with Scientific Instruments," and the second by Sir Gilbert Walker on "The Physics of Sport."

Among the demonstrations given by the Gramophone Company was a display of television, on a system developed by the company's research staff at Hayes, Middlesex. The work has reached the stage of an advanced laboratory experiment, but there is no intention of exploiting it commercially at present. The aim of the company is to produce a form of television that will be of definite entertainment value, without which, it is considered, no system can hope to be commercially successful. Attention has been concentrated on two points—the employment of a large number of picture elements to each unit area of the picture, in order to get definition, and some means of modulating the strong light needed to give an image of real entertainment value. The second of these requirements has been met by using a powerful arc lamp and designing apparatus to control this powerful source of illumination.

In the experiments which are to be shown at the exhibition, cinema pictures are transmitted along cables, and reconstructed on a screen measuring about 24 in. by 20 in., without the aid of lens magnification. Although for this demonstration the transmitter and receiver will be only a short distance apart, there would be no difficulty in using cables of any length between them. At a private view at the Gramophone Company's works some days ago, several film pictures were successfully transmitted by the apparatus, including pictures of street scenes in London and of a cricket match. The pictures are scanned at the transmitter in five sections of thirty lines each, a lens drum being used to traverse a succession of images over five scanning apertures. Photo-electric cells placed behind these apertures generate currents corresponding to the picture elements, and these currents are amplified and transmitted along five separate channels. At the receiver, further amplification is necessary before the picture pulses are applied to a multiple Kerr cell. The received image is reconstructed by means of a mirror drum driven synchronously with the transmitter, and thus projected on the screen.

BUDGET FOR THE U. S. DEPARTMENT OF AGRICULTURE

ACCORDING to *The Official Record* the budget of the U. S. Department of Agriculture for the fiscal year 1932 as submitted by the President to the Congress recommends that a total of $225,537,476 (including $137,500,000 for roads) be provided for all activities conducted or administered by the department, as compared with $174,345,474 for all purposes for the fiscal year 1931, or an increase of $51,192,002 over total funds appropriated for 1931 up to December 1, 1930.

The 1932 budget includes a proposal for the establishment in the department of a Bureau of Agricultural Engineering, to which the work now conducted by the division of agricultural engineering of the Bureau of Public Roads, together with a portion of the appropriation of the latter bureau for general administrative expenses, is recommended to be transferred. As all the operations of the farm which involve the use of construction materials, labor, power, machinery and improvement of the land by irrigation, drainage and erosion lie partly within the field of engineering, it is felt that, in order to secure the most effective coordination of effort within the department and in its relations with the state agricultural colleges and experiment stations and with commercial and other non-governmental agencies, the agricultural engineering work should be segregated from road construction activities and set up as a distinct unit coordinate with the other major subdivisions of the department.

The recommended increases for 1932 include items totaling approximately $1,200,000 for expanding the research of the department, and $700,000 additional for continuing the building program at the forest products laboratory at Madison, Wisconsin. Among the increases for research are $30,000 for animal husbandry investigations; $25,000 for poultry investigations; $63,000 for investigating diseases of livestock; $80,000 for dairy research projects; $180,000 for investigations of the Bureau of Plant Industry; $227,000 for forestry research under the McNary-McSweeney Act; $113,000 for projects of the Bureau of Chemistry and Soils; $156,000 for research by the Bureau of Entomology; $93,000 for activities of the proposed new Bureau of Agricultural Engineering; $210,000 for marketing investigations of the Bureau of Agricultural Economics; $40,000 for investigations of the Bureau of Home Economics, and $70,000 for expanding the soil-erosion program. Also an increase of $58,000 is recommended in the department appropriation for printing, a large part of which is for the publication of manuscripts on scientific subjects.

The budget also includes increases of $21,000 for the motion-picture work of the Extension Service; $360,000 for extending the service of the Weather Bureau in aid of civil aviation, under the air commerce act; $250,000 for payment of indemnities in connection with tuberculosis eradication in California; $186,000 for the administration and protection of the national forests and $280,000 for construction and maintenance of national forest improvements; $75,000 for cooperation with states in fire control on state

and privately owned timberlands, under the Clarke-McNary Act; $28,000 for the protection of migratory birds, $200,000 for the acquisition, maintenance and administration of bird refuges under the migratory bird conservation act, and $150,000 for the acquisition of additional lands for the Cheyenne Bottoms Bird Refuge, under the Bureau of Biological Survey; $25,000 for extending the market inspection service, $43,000 for the market news service, $300,000 for enforcement of the perishable agricultural commodities act of June 10, 1930, $23,000 for enforcement of the grain standards act, and $57,000 for the administration of the warehouse act, under the Bureau of Agricultural Economics; $70,000 for strengthening the plant-quarantine inspection service of the Plant Quarantine and Control Administration; $27,000 to provide more adequately for the enforcement of the grain futures act; $200,000 for increasing inspection and analytical work connected with the enforcement of the food and drugs act; and $35,000 for the collection of loans made to farmers in previous years in flood, storm and drought-stricken areas.

The budget provides for the transfer of the department's experiment station at Fairbanks, Alaska, to the Alaska Agricultural College and School of Mines, and for the abandonment of the department stations at Sitka and Kodiak, Alaska, entailing a reduction of $28,750, which, however, is offset in part by a recommended appropriation of $15,000 to be paid to the Territory for the agricultural experiment station. Other decreases in the budget include $75,000 for operation of Center Market in Washington, on account of the proposed closing of this market on January 1, 1931, in connection with the federal building program; $50,000 for corn borer control, incident to removal of the requirement with respect to certain regulated products, and $30,000 for control of the Asiatic beetle, due to the lifting of the quarantine against this pest.

Provision is made in the budget for an increase from $11,000,000 to $12,500,000 for forest roads and trails and from $75,000,000 to $125,000,000 for federal-aid highways in connection with the enlarged construction programs contemplated by the acts of April 4, 1930, and May 5, 1930.

Included within the increases provided by the budget for 1932 is a total of $268,287 for salary adjustments under the provisions of the Brookhart Salary Act of July 3, 1930, amending the classification act of 1923. This amount is exclusive of approximately $30,000 for Brookhart Act salary adjustments of employees carried on certain special appropriations, such as the Federal-aid highway and forest road and trail funds, which have been absorbed by these appropriations without increase in their totals.

The budget also includes, distributed throughout the appropriation items, recommended increases totaling $223,820 for underaverage salary grade adjustments.

CHECK LIST OF THE BIRDS OF THE WORLD

THE Museum of Comparative Zoology announces that the first volume of a Check List of the Birds of the World by James Lee Peters is now in press and will be issued shortly.

The classification followed for the higher groups is that proposed by Dr. Wetmore, with the sequence of genera and species according to the author's own ideas where no authoritative treatment has been published. The first volume will contain about three hundred genera and one thousand seven hundred species and subspecies covering the following orders:

Struthioniformes, Rheiformes, Casuariiformes, Apterygiformes, Tinamiformes, Sphenisciformes, Gaviiformes, Colymbiformes, Procellariiformes, Pelecaniformes, Ciconiiformes, Anseriformes, Falconiformes.

The only recent attempt to list most of the species in these groups was that made in the first volume of Sharpe's Hand-list published in 1899 and consequently now thirty-two years old and out of date.

It is expected that at least ten volumes will be required to complete the work. The second volume is in active preparation and preliminary work on others is under way.

The new check list is not a museum publication and will not be distributed to the museum's exchange list, but will be published by the Harvard University Press.

CONFERENCE ON HUMAN PROBLEMS IN INDUSTRY

A SCIENTIFIC study of human problems in industry, directed at the roots of such social evils as unemployment, middle-age obsolescence, labor unrest and strikes, will be made at the Institute of Human Relations at Yale University, with the cooperation of leading industrialists and engineers, according to an announcement made following a conference on January 13 in New Haven between a committee of the American Society of Mechanical Engineers and members of the institute.

Members of the committee, which will act in an advisory capacity in the study, are E. W. Rice, Jr., honorary chairman of the board, General Electric Company, Schenectady, N. Y.; H. E. Howe, editor, *Industrial and Engineering Chemistry*, Washington, D. C.; Ralph E. Flanders, general manager, Jones and Lamson Machine Co., Springfield, Vermont; D. M. Bates, president of Bates, Inc., Philadelphia; J. P. Jordan, partner of Stevenson, Harrison and Jordan, New

York City; and Henry M. Crane, technical assistant to the president of General Motors Corporation, New York City. Members of the institute at the conference were Dean Charles H. Warren, Sheffield Scientific School; Dean M. C. Winternitz, Yale School of Medicine; Dean Edgar S. Furniss, Yale Graduate School; George Parmly Day, treasurer, Yale University; Professor S. W. Dudley; Professor Mark A. May, executive secretary of the Institute of Human Relations, and Professor Elliott D. Smith, Yale University, director of the study.

The industrial committee of the institute, already formed and at work, includes among others a psychiatrist, a psychologist, an economist, a lawyer and a sociologist, directed by an engineering and management group interested in focusing the attention of these specialists upon various phases of the development of human problems in specific industrial organizations.

"In the solution of this problem," the committee states, "there arise many important questions related to the major human sciences; such physiological problems as fatigue, such medical problems as occupational diseases, such psychological problems as capacity to learn, such psychiatric problems as the emotional effects of fear of loss of job, such social problems as absorption by the community of workers thrown out of employment, such economic problems as the absorption of increased output, such legal problems as adaptation of labor legislation to technological change, while in its very structure it is a problem of engineering and of management."

The first instance of increased technological efficiency to be studied will be the "stretch-out"—the recent rapid increase in the number of spinning frames and looms tended by the individual worker. This preliminary study will provide material for a comparison of procedures and effects. It will be a contribution of distinct practical value, the committee believes, by calling to the attention of managers the nature of the social problems involved and the extent to which they are dependent upon good managerial handling.

AMERICAN ASSOCIATION OF TEACHERS OF PHYSICS

AT the Cleveland meeting of the American Association for the Advancement of Science an organization was formed for the purpose of promoting and improving the teaching of physics of college and university grade, under the name "American Association of Teachers of Physics." The new organization fills a need long felt by those interested in methods of instruction, from the pedagogical as well as from the laboratory and demonstration points of view. A tentative constitution was adopted, and an executive committee chosen to perfect plans for the organization, which are to be discussed and acted upon at the New Orleans meeting. Regional, as well as general, meetings are to be held. The first general meeting is to take place at the Bureau of Standards in April, in connection with the regular meeting of the American Physical Society. At this meeting, Dr. A. W. Hull, assistant director of research of the General Electric Company, will present a paper on the training of physicists for industry.

Officers elected for the ensuing year are: *President,* Dean Homer L. Dodge, University of Oklahoma; *Vice-president,* Dr. P. E. Klopsteg, Central Scientific Company; *Secretary-Treasurer,* Professor W. S. Webb, University of Kentucky. The executive committee consists of the officers and the following members: Professor O. B. Blackwood, University of Pittsburgh; President Karl T. Compton, Massachusetts Institute of Technology; Professor R. S. Minor, University of California; Dean F. K. Richtmyer, Cornell University; Professor M. N. States, University of Kentucky; Professor B. A. Wooten, University of Alabama. Applications for charter membership will be received until June 1, 1931.

SCIENTIFIC NOTES AND NEWS

THE William Wood Gerhard Gold Medal of the Pathological Society of Philadelphia was presented on January 8 to Dr. Simon Flexner, director of the Rockefeller Institute for Medical Research.

PROFESSOR ERNST VON ROMBERG, of Munich, informs the *British Medical Journal* that the commission entrusted with the grant of the Dr. Sophie A. Nordhoff-Jung Cancer Prize for the best work of recent years in the field of cancer research has unanimously awarded this prize to Dr. Alexis Carrel, of the Rockefeller Institute for Medical Research, for his development of the method of tissue cultivation and his application of it in the solution of the basic problems of pathological growths, especially the growth of malignant tumors. The commission was composed of Professors Borst, Döderlein, von Romberg and Sauerbruch.

THE Geological Society of London on January 16 awarded the Bigsby Medal to Dr. Norman L. Bowen, of the Geophysical Laboratory of the Carnegie Institution at Washington, in recognition of the value of his study of the physical chemistry of igneous rocks.

AWARD of the William H. Nichols Medal of the New York Section of the American Chemical Society for 1931 to Dr. John Arthur Wilson, of Milwaukee, Wisconsin, is announced. The award, bestowed for outstanding achievement in colloid chemistry, applied particularly to leather and sanitation, will be presented to Dr. Wilson at a national gathering of chemists in New York on March 13. Speakers at the ceremony will include Professor Arthur W. Thomas, of Columbia University, and Dr. Clarke E. Davis, production manager of the National Biscuit Company.

DR. HERBERT LEVINSTEIN, the English chemist, has been awarded the medal of the Society of Chemical Industry. The medal is awarded not more frequently than once every two years for "conspicuous services to applied chemistry by research, discovery, invention or improvement." Dr. Levinstein, who is the eighteenth recipient of the honor, did much work on the Chemical Warfare Committee and is known as an authority on poison gas.

THE Swedish Gold Medal for physical education, awarded by the Swedish Gymnastic Federation, was presented to Dr. Philippe Tissié at the International Ling Congress, recently held at Stockholm.

DR. E. R. CUMINGS, head of the department of geology of Indiana University, was elected president of the American Paleontological Society at the twenty-second annual meeting at Toronto.

DR. W. P. FRASER, of the University of Saskatchewan, has been elected president of the Phytopathological Society of Canada.

THE Pathological Society of Philadelphia has reelected for the year 1931 the officers of the previous year, namely, Dr. Balduin Lucke, *president;* Dr. V. H. Moon, *vice-president,* and Dr. Isolde T. Zeckwer, *secretary-treasurer-recorder.*

DR. KARL VON GOEBEL, professor of botany in the University of Munich, has been elected president of the Bavarian Academy of Sciences.

PROFESSOR EDWARD SAPIR, of the University of Chicago, has been appointed Sterling professor of anthropology and linguistics at Yale University. Dr. Sapir will also be a member of the staff of the university's Institute of Human Relations and will act as chairman of a new section of the department of social sciences devoted to cultural anthropology.

DR. MARGARET E. MALTBY, associate professor of physics at Barnard College, will retire at the end of the college year after serving as a member of the faculty for thirty years.

DR. OWEN THOMAS JONES, Woodwardian professor of geology at the University of Cambridge, has been elected to a professorial fellowship at Clare College.

DR. HERMON CAREY BUMPUS has been appointed chairman of the educational advisory board of the National Park Service, succeeding Dr. John C. Merriam.

THE members of the new National Advisory Health Council, created by an act of Congress to advise the Surgeon General of the U. S. Public Health Service on matters pertaining to the health of the country at large, have been appointed. Four members of the advisory committee of the old Hygienic Laboratory who will serve on the council are: Dr. Simon Flexner, director of the Rockefeller Institute for Medical Research; Dr. M. P. Ravenel, professor of bacteriology at the University of Missouri; Dr. M. J. Rosenau, professor of public health and hygiene at the Harvard Medical School, and Dr. William H. Welch, of the Johns Hopkins University. The other members are: Dr. W. S. Leathers, dean of Vanderbilt University School of Medicine; Dr. Haven Emerson, professor of public health and hygiene at Columbia University; Professor S. C. Lind, head of the departm nt of chemistry, University of Minnesota; Dr. W. H. Howell, director of the Johns Hopkins School of Hygiene; Dr. C.-E. A. Winslow, professor of public health at Yale University, and Dr. Alfred Stengel, professor of the practice of medicine at the University of Pennsylvania.

DR. EDWARD LAURENS MARK, of Harvard University, director of the Bermuda Biological Research Institute, sailed for Bermuda on January 17. He was accompanied by a number of scientific men, including Dr. Charles Benedict Davenport, Dr. Ross Granville Harrison and Dr. Edwin Grant Conklin.

DR. JOHN C. MERRIAM, president of the Carnegie Institution; Dr. A. V. Kidder, chairman of the division of historical research, and Mr. H. B. Roberts, staff archeologist, have left Washington to undertake a tour of inspection of the ruins of the old Mayan Empire in northern Guatemala. They were expected to reach Puerto Barrios about January 19. The ruins at Uaxactun, the oldest of known Mayan cities, have been the scene of Carnegie Institution excavations since 1926. In addition it is planned to make a brief reconnaissance of certain areas which have been considered in connection with the program of the institution.

PROFESSOR M. F. JORDAN, of the University of Maine, is spending a sabbatical leave at the Perkins Observatory, conducting special investigations in cooperation with the research program of the observatory.

DR. CHARLES H. ROGERS, of the department of pharmaceutical chemistry of the University of Minnesota, will leave in March for Europe, where he will join Mrs. Rogers, who has been spending the winter in Spain, northern Africa and France with Professor and Mrs. Francis B. Barton, of the department of Romance languages. Besides touring through the principal continental countries, Dr. Rogers will study the chemical and pharmaceutical plants in Europe. He and Mrs. Rogers will return to Minneapolis in time for the fall quarter.

DR. MELVILLE J. HERSKOVITS, associate professor of anthropology at Northwestern University, sailed from New York on January 21 for a six months' expedition to West Africa, to seek further evidence that the slaves of Cuba, Hayti, Brazil and the United States came from this part of West Africa.

PROFESSOR PAUL EHRENFEST, of the University of Leiden, visited the Bartol Laboratory of the Franklin Institute from January 6 to 17, where he conducted a series of colloquia on "Atomic Physics."

DEAN R. L. SACKETT, of the School of Engineering at the Pennsylvania State College, is making a speaking trip through the southern universities at the behest of the American Society of Mechanical Engineers. He will also address the Atlanta and New Orleans sections of the society. Dean Sackett expects to go as far west as Tucson, Arizona, where he will remain for several weeks. He will speak to engineering students in other institutions on his way back, returning to State College in April.

ON December 9, Dr. S. O. Mast, professor of zoology at the Johns Hopkins University, lectured at Cleveland, under the auspices of the McBride Lecture Fund. The subject of his discourse was "Concealing Coloration in Animals."

DR. A. M. BANTA, research professor of biology at Brown University and research associate of the Carnegie Institution, delivered an address on "What the Crustacean Tells us about Evolution," before the Washington Academy of Sciences on December 18.

DR. ALEXANDER SILVERMAN, head of the department of chemistry of the University of Pittsburgh, delivered an illustrated lecture on "The Chemistry and Technology of Glass" before the University of Illinois Section of the American Chemical Society on January 12. The lecture was also given before the Indianapolis Section on January 13, and before the Purdue University Section on January 14.

DR. KARL T. COMPTON, president of the Massachusetts Institute of Technology, recently addressed the Students' Liberal Club on "What Can Science Say Concerning the Origin of Life and the Destiny of the Universe?"

DR. KARL MENGER, professor of mathematics in Vienna, who is lecturing at Harvard University during the winter semester, will lecture during the summer at the Rice Institute, Houston, Texas, on metrical geometry and on the dimension and curve theory.

UNDER the auspices of the Harvard division of philosophy, Professor R. F. Alfred Hoernlé will give a lecture on "Theory of Knowledge at the Crossroads" on January 28. Professor Hoernlé was assistant professor of philosophy at Harvard during the years 1914–20, and is now professor of philosophy at the University of the Witwatersrand, Transvaal, South Africa.

DR. OTHENIO ABEL, professor of paleontology and paleobiology at Vienna, will deliver this spring a course of lectures at the University of Paris.

A BUILDING to be erected for the Harvard College Observatory at a cost of $100,000 is planned for the safe preservation of the photographic collections and other records of the observatory. Irreplaceable pictures of all portions of the sky—the first made in 1850—taken from the Northern and Southern Hemispheres and now stored in a wooden building, will be laid away for future study and reference in special vaults which will be placed in the projected building. Numbering more than 350,000 plates, and collected at a cost in excess of $1,000,000, the collection is five times larger than that of any other institution in the world. Space will be allowed for the collections of the next forty years.

A GIFT of $700,000 eventually will go to the Johns Hopkins Hospital by the will of William A. Marburg, former vice-president of the American Tobacco Company, which disposes of an estate of $2,100,000. The $700,000 goes to the hospital upon the death of the last surviving child of Theodore Marburg, formerly minister to Belgium, a brother of William Marburg. Another trust fund of $50,000 for his sister is to go to the hospital upon her death.

Museum News states that: The Cleveland Museum of Natural History has been given a 100-acre tract of land on Sperry Road to be developed as an arboretum. With the land goes assurance of cooperation and financial backing by the trustees of a large private estate of Cleveland. The land was given to the museum by Mr. and Mrs. Benjamin Patterson Bole and their son, Benjamin Patterson Bole, Jr. For its development as an arboretum the museum will have the larger part of the income from the Elizabeth Davis Holden Memorial Fund, established by the late

Albert F. Holden, Mrs. Bole's brother. In addition, Mr. and Mrs. Bole have given the museum an option to buy additional lands on the basis of present values, and will provide funds for preparing the program of the arboretum, which will be known as the Holden Arboretum. Announcement of the gift and the plan of cooperation between the museum and the trustees of the Holden estate was made at a dinner, attended by 441 people, in celebration of the tenth anniversary of the establishment of the museum.

THE council of the senate of the University of Cambridge has recommended the acceptance of the offer of the council of the Royal Society to provide within three years a sum of £15,000 towards the building and equipment of a laboratory for special physical investigations in the University of Cambridge, to be used in the first instance for magnetic and cryogenic research.

THE editor of *Chemical Reviews*, Dr. Gerald Wendt, announces that beginning with 1931 the journal will be doubled in volume, carrying twice as much material as heretofore. The journal will be published in two volumes instead of one, and will be changed from a quarterly to a bi-monthly. The volumes will begin in February and August. The expansion makes it possible for *Chemical Reviews* to publish promptly the papers of the important symposia of the society, as well as others from all over the world. To members of the American Chemical Society *Chemical Reviews* will continue to sell for $4.00 a volume, or $7.00 for both volumes when they are ordered at one time. The price to non-members is $5.00, or $9.00 for both volumes.

Industrial and Engineering Chemistry reports that the thirteenth exposition of Chemical Industries will include exhibits on three floors of the Grand Central Palace, New York, devoted to the raw materials for the manufacture of chemicals and chemical products, technical products used in the arts and industries, apparatus and equipment, machinery and the finished products of the chemical industries. The exposition will be held during the week of May 4, 1931. Special sections will be devoted to the showing of raw materials from the Southern States, the natural resources of Canada and its provinces, new metals and alloys, laboratory supplies and equipment, materials handling and containers. The machinery and apparatus will vary from laboratory equipment through instruments of precision to equipment for large-scale operations. Special fundamental operations of the chemical industries will be shown in demonstrations including disintegration, crushing, grinding, grading, mechanical separation, including filtration, classification, settling, thickening, evaporation, distillation, drying, weighing, measuring, mechanical handling and conveying. Demonstration of the materials of construction will include ceramic materials, glassware, metals, alloys, plastics, wood fibers, fabrics and materials developed for special purposes. The students' course on the fundamentals of chemistry and chemical engineering will again be under the chairmanship of W. T. Read, dean of the School of Chemistry at Rutgers University.

Nature states that the section for scientific and optical instruments and photographic apparatus at the British Industries Fair, Olympia, London, which will be held from February 16 to 27, will occupy some 6,000 square feet on the ground floor of the Grand Hall. A joint exhibit has again been organized by the British Optical Instrument Manufacturers Association. There will be instruments for all branches of research and industry and for educational purposes, including a particularly fine exhibit of visual aids to teaching. It is, perhaps, not generally known that British manufacturers of optical glass supply lenses to America for cinema cameras and projectors, and that one firm is actually exporting the bulk of its spectacle lenses to the United States. Every kind of modern optical instrument is obtainable from British manufacturers, and there are some British instruments not made elsewhere which are used all over the world, including Germany. There will be a novel display of marine and aerial lighting equipment, including a flashing buoy-light and aerodrome floodlights and models of lighthouses and airway beacons. The section for chemicals at the fair will occupy some 11,000 square feet on the ground floor of the grand hall. Invitations to the fair may be obtained by scientific workers, teachers and others on application to the Department of Overseas Trade, London, which entitle the holder to travel to and from the fair by rail at the rate for a single journey plus a third.

AN exhibition of the Andrée Expedition relics opened in Liljevalch's Art Gallery in Stockholm on January 6. The exhibition, which occupies eight large rooms, consists of 550 objects, and gives a vivid impression of the immense difficulties surmounted by Andrée and his two companions in carrying such a large number of things, including a big canvas boat three sledges, food supplies, and a medicine chest, still well stocked. Special interest centers in Andrée's woollen jersey, in which the famous notebook was wrapped; the Primus stove, which still works perfectly; and lantern slides reproduced from the 30 or so remarkable photographic negatives skilfully developed after they had rested 33 years in an icy wilderness.

Industrial and Engineering Chemistry states that at the Atlanta meeting the council of the American

Chemical Society instructed the secretary to report at Cincinnati upon possible plans for providing retiring annuities for the staff of the society. This report was made and the council recommended action on the part of the directors. The directors have now voted that present employees of the society after twenty-five years of service, having hereafter reached the age of at least sixty years, shall on retirement be paid annually for life an amount equal to one per cent. of their average salary for the last five years of their service, multiplied by the number of years of service. It is further understood that this action shall not in any way affect the right of the society to discharge any employee. The directors further instructed the treasurer to set aside a reserve fund of $50,000 for employees' retirement, and recommended to future directors that the amount of the fund be adjusted as needed.

DISCUSSION

THE OCCURRENCE OF NATURAL AND ACQUIRED IMMUNITY TO INFECTIOUS MYXOMATOSIS OF RABBITS[1]

IN reporting investigations concerning the virus of infectious myxomatosis of rabbits, Moses (1911)[1] noted that the wild rabbit of Brazil was resistant to infection except in rare instances. In our work with the virus the common laboratory rabbit has proved susceptible in every case, over two hundred and fifty rabbits being used for various experiments during the last five years. Findlay (1929)[2] has reported the Belgian hare to be susceptible and we have found the Flemish Giant likewise susceptible. This would be expected since they are varieties of the common laboratory rabbit.

In an earlier paper (Hobbs, 1928),[3] it was suggested that the western jack rabbit and the varying hare or northern snowshoe rabbit might also be immune to this virus. Since then it has been possible to secure live specimens of *Lepus californicus* Gray, the black-tailed jack rabbit, *Lepus americanus* Erxleben, the varying hare, and *Sylvilagus transitionalis* Bangs, the common wild cottontail. Two animals of each species were obtained and all proved immune to skin inoculation with the infectious myxomatosis virus. As is true in certain of the other virus diseases, this natural immunity seems to be a tissue immunity since it has not been possible to demonstrate any virucidal property in serum from either the jack rabbit or the wild cottontail. Whether this immunity can be broken down by means of giving massive doses of virus or by using other routes of inoculation and whether virucidal antibodies can be produced in these wild hares and rabbits are among the several problems that suggest themselves.

In the large number of laboratory rabbits which have been used in our experimental work, only one individual has shown any signs of resistance to the virus and it was a member of a group that had received repeated injections of killed virus. It had a severe case but eventually recovered and has proved immune to subsequent inoculation. That its resistance was due to the previous injections of killed virus can not be claimed, of course, since Sanarelli (1898)[4] reported that two of his animals recovered spontaneously from the infection. Virucidal antibodies were demonstrable in its blood two months after its recovery and are still demonstrable, eighteen months after recovery by means of the following technique. A 5 per cent. suspension of virus was prepared by grinding freshly removed myxomatous tissue in normal saline in a mortar. The suspension was then centrifuged for fifteen minutes at low speed and 0.5 cc quantities of the supernatant added to 0.5 cc quantities of serum from the above rabbit, of normal rabbit serum and of normal saline. These mixtures were then incubated at 37° C., being shaken every thirty minutes. At the end of two hours, the mixtures were removed and inoculated into susceptible rabbits. The rabbits inoculated with the immune serum mixtures never showed any signs of myxoma at the sites of inoculation or elsewhere, while the control rabbits developed typical myxoma nodules at the sites of inoculation and died from the infection.

These experiments would suggest the existence of a genus immunity to infection as the laboratory rabbits all belong to the genus *Oryctolagus* (not *Sylvilagus* as stated in my earlier paper), while the wild hares are placed in the genus *Lepus* and the wild wood hares or cottontails of North and South America are placed in the genus *Sylvilagus* according to the classification of M. W. Lyon given in the Encyclopaedia Britannica, thirteenth edition, 1926. In this the wild rabbit of Brazil is called *Sylvilagus* (not *Lepus*)

[1] A. Moses, "O virus do mixoma dos coelhos," Mem. Inst. Oswaldo Cruz, 3, 46, 1911.

[2] G. M. Findlay, "Notes on Infectious Myxomatosis of Rabbits," *Brit. Jour. Exp. Path.*, 10, 214, 1929.

[3] J. R. Hobbs, "Studies on the Nature of Infectious Myxoma of Rabbits," *Amer. Jour. Hyg.*, 8, 800, 1928.

[4] G. Sanarelli, "Das myxomatogene Virus," *Centr. Bakt.*, Abt. 1, 30, 865, 1898.

braziliensis and is said to be very closely related to the wild cottontail of North America. Whether European species of *Lepus* and wild species of *Oryctolagus* would show a natural immunity to this virus is an interesting conjecture.

Our experiments are being continued and will be more fully reported at a later date.

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NOTE ON THE CORN COMPONENT OF A RACHITOGENIC DIET

IN working with white rats and rickets the authors have found irregularity in the development of rickets on the Steenbock Diet 2965. The trouble has been traced apparently to the yellow corn component of the diet, and a satisfactory remedy was derived from the following experiment.

Thirty pounds of whole grain market yellow corn were equally divided. One half was immediately placed in a loosely covered earthenware crock, and the other half ground finely before storage in a similar container. Each lot was held at the variable room temperature of a dry laboratory for one year. At the end of this period of time the whole grain corn was ground in the same machine previously used, and twin batches of the above diet were compounded from these two samples of ground corn. The difference, obviously, was that one batch of meal was freshly ground from old corn, while the other batch had been aged as meal. A third lot of diet mixture employed corn-meal bought at a grocery.

The three diet mixtures were fed to animals selected equally from three litters of rats, and on the twenty-fourth day all animals were diagnosed by X-ray and line test, with the following result.

No. of animals	Peculiarity of diet	Positive rickets	Ave. gain in weight
6	Freshly ground corn	none	27 grams
6	Aged ground corn	6	19 "
6	Market corn-meal	6	8 "

We do not find in the literature the caution that whole market corn may contain an amount of anti-rachitic factor sufficient to interfere with desired development of rickets in white rats, if the corn be used freshly ground, but only the notation that storage of ground corn is attended with loss of growth-promoting factor. Since it is desirable to retain the growth-promoting vitaminic power but is imperative to avoid excess of antirachitic factor, one seems to be between the horns of a dilemma in respect to the corn component of this diet. A reasonable solution seems to be to store the ground corn-meal for six months and use it up in the next few months, and this procedure, for want of one more exact, serves as a successful expedient for insuring the development of a definite rachitic condition in white rats on a definite time schedule, with a simultaneous reasonable rate of gain in weight.

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WHEAT MOSAIC IN EGYPT

IN 1927–1929 the writer began investigations on a "new" wheat disease in Egypt for the Egyptian Ministry of Agriculture. It seems advisable to present a preliminary note at this time; later a complete paper will be published on various aspects of the problem. This disease was called to the writer's attention in December, 1927. The crop of 1928 was severely attacked. It was present to a somewhat less degree in the wheat crop of 1929 and has been reported to the writer as occurring in the crop of 1930.

In December, 1927, many completely yellow or chlorotic plants were sent to the mycology laboratory of the Giza agricultural farm. The same condition appeared on certain varieties of wheat in the varietal plots at Giza. The characteristic yellow color or chlorotic condition of the early stages of growth (when the plants were from one to two months of age) suggested the tentative names "yellows disease" or "wheat chlorosis," names by which it became known in Egypt. This condition was said never to have been seen on wheat in Egypt prior to 1927, and many explanations for its cause were forthcoming from staff members of the several divisions of the Ministry of Agriculture as well as from laymen.

Circumstantial evidence as well as established facts convince the writer that this malady had been present in Egypt for several years prior to the outbreak of 1928 but had escaped notice.

Diseased plants were scattered in a field and were not restricted to definite areas. There was no definite relation with respect to soil conditions. Normal plants were found next to a group of diseased individuals. The Hindi variety, one of the standard wheats of Egypt, was especially susceptible. Many fields were observed that had from 40 to 60 per cent. of the plants badly affected. The yield in these fields was reduced 20 to 40 per cent. Badly diseased plants were completely yellow or chlorotic in the early stages of growth and as the tillers began to form. The root

system at this age of the plant was apparently normal in expanse. Some plants died and appeared to be starved to death, but most of them reached maturity. Badly diseased plants never became more than one third or one quarter the size of a normal plant, having about the same number of culms but very small heads and shriveled grain. Plants which were completely yellow rarely showed any additional leaf or sheath symptoms as the season progressed. Those not completely yellow in the early stages, or which appeared normal up to the shooting stage but were slightly infected, characteristically showed yellow striping the entire length of the leaf, or mottled areas of yellow mosaic of short or long streaks. This sometimes occurred on only a few of the leaves. At times the writer discovered symptoms of green mosaic on the leaf and sheath, but this was exceedingly uncommon.

The rosette disease of wheat and the rosette of barley occur in Egypt. It is problematical how long these have been in Egypt, although members of the Ministry of Agriculture state they have been since 1925, but there is no published record to this effect. The writer found the rosette of wheat and barley in 1927 in many of the Egyptian provinces. He found barley affected also with what appeared to be a similar striping and yellow mosaic, and, from general appearances, indistinguishable from certain of the rosette mosaic symptoms occurring on wheat in the United States.

Data have been secured on varietal resistance to these diseases in wheat and barley, the effect of dates of planting, the effect of the "dry" and "wet methods" of sowing wheat, and the relation of soil temperatures and the occurrence of these mosaics. Also limited studies were made on artificial transmission of the disease by expressed juice and infested soils.

In light of the studies made on this wheat disease in Egypt, the writer regards it as one of the wheat mosaics and probably associated with the rosette disease. The reaction of certain varieties of spring wheat from the United States supplied by H. H. McKinney and grown in Egypt indicates that the viruses in Egypt and in the United States are dissimilar. This is substantiated by trials made of Egyptian varieties by McKinney[1] in the United States.

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THE FATAL BELGIAN FOG

ABOUT the week-end of December 7, an extremely heavy fog prevailed in Belgium and England, and the daily press reported that in the neighborhood of Liège more than forty persons and a considerable number of cattle died, exhibiting symptoms of asphyxiation. Autopsies performed on twelve cows indicated that they had died from pulmonary edema. Although final judgment on this phenomenon must await the results of the investigation which the Belgian government has undertaken, there are certain aspects of the situation which might be here referred to.

According to the New York *Times*, of November 30, 1930, a terrific sand-storm and hurricane blew over French Morocco on November 27. The following night, yellow sand was heavily deposited on the streets and on the foliage at Barcelona, Spain. On the morning of November 28, a "mud rain" fell in Paris and all over northern France as far west as Granville, on the southern Brittany coast and along the English Channel.

It seems probable that the more finely dispersed material carried by this storm reached considerable heights and settled down slowly over Belgium and England. These colloidal or semicolloidal dust particles served to reinforce the normally high atmospheric nucleation of the winter season; for, as Carl Barus has shown (Smithsonian publication 1309, published 1905) the products of combustion (burning coal, etc.) furnish highly efficient nuclei, and this atmospheric nucleation is especially marked in industrial neighborhoods and in the winter season. The tiny nuclei serve as centers about which, under suitable atmospheric conditions, moisture will deposit to form fog droplets. The extremely fine dust will continue to settle down for days and, given a sufficiently still and moisture-depositing atmosphere, prolonged and dense fogs would be expected.

This view is further confirmed by the fact that the *Evening Sun* of December 19, 1930, reported another terrific storm which swept over northern Algeria following a disastrous seven months' drought. Today's New York *Times* (December 22) carries a heading "Worst Fog in Years Paralyses London" (visibility only three feet at times).

The quantity of dust moved by storms of this character may be gauged from the fact that Hellman and Meimardus state that a cyclonic storm centered over Tunis about March 8 to 10, 1901, sucked up such a cloud of dust from the deserts that about one third of the 1,800,000 tons of dust that fell in Europe dropped north of the Alps. Apart from what fell into the Mediterranean Sea, they figured that about 150,000,000 tons were deposited on the African coast. Miller and Winchell estimated that the million or so tons of dust which fell with snow over an area of

[1] H. H. McKinney, "A Mosaic of Wheat Transmissible to All Cereal Species in the Tribe Hordeae," *Jour. Agr. Res.*, 40: 547–556, 1930.

about 100,000 square miles from Dubuque, Iowa, to Chelsea, Vermont, must have been carried over 1,000 miles at high altitudes from the arid southwest (Arizona and New Mexico) *before* it began to settle down.

It would seem probable, therefore, that the formation of fog in England and Belgium would easily be increased over a reasonable period of time following storms of the character recently reported.

The next point to consider is why, in certain localities, the fog was followed by fatalities. The following suggestion is offered as a possibility:

The newspaper reports indicate that the persons and animals were attacked suddenly with symptoms which, because of their abruptness and nature, lead one to suspect that they were in the nature of anaphylactic phenomena. The time of exposure prior to seizure was much too short to suggest the possibility of bacterial infection, and there seems to have been no ground whatever for the initial surmise that some hidden store of war poison-gas had suddenly escaped. It would seem possible that the heavy fog, in settling down, had accumulated in and on its droplets substances which precipitated the onset of anaphylactic shock in persons and animals previously sensitized. Thus, for example, it might be possible that castor bean cake containing the poisonous protein ricin had been used as a fertilizer in that neighborhood, and that some men and animals had become sensitized to it. The fog, in settling, might have accumulated and brought into the lungs of these sensitized beings sufficient ricin dust to occasion the onset of anaphylaxis. A few years ago, SCIENCE printed a note from a professor who had become sensitized to ricin and who had a violent attack of "hay fever" when someone in his laboratory merely opened a bottle of castor beans.

We do not, of course, know anything about the local situation, but it would be well if the possibility above suggested be kept in mind and search be made for conditions and substances which might be responsible for the onset of asthmatic or anaphylactic manifestations.

JEROME ALEXANDER

SPECIAL CORRESPONDENCE

COMMITTEE ON DRUG ADDICTION OF THE NATIONAL RESEARCH COUNCIL

IN January, 1929, the Bureau of Social Hygiene, Inc., offered to the National Research Council a sum of money to be spent in the study of drug addiction. The council accepted the funds and appointed in its Division of Medical Sciences a Committee on Drug Addiction to draft a plan of research work. The members of this committee are: Wm. Charles White, Charles W. Edwards, Carl Voegtlin, Torald Sollmann, Reid Hunt, C. S. Hudson, F. B. LaForge, Walter L. Treadway, Ludvig Hektoen, and the chairman of the Division of Medical Sciences.

After numerous conferences with those best equipped to give advice, the committee concluded that there were two avenues of study that might bring some help in the problem of drug addiction and it adopted these avenues as the most likely to succeed.

The first avenue of approach would be an attempt to replace all the uses to which addiction drugs are put by drugs without addiction properties. The basis for this attempt was: (*a*) that morphine had a high addiction property while codeine had a comparatively low addiction property, and codeine can replace many uses of morphine if used in larger doses; (*b*) that since the replacement of practically all the uses of cocaine, except in the surface application for anesthesia, with drugs having little or no addiction properties the importation of coca leaves has declined. That the latter condition should occur held out hope that if all the uses made of addiction-producing drugs could be limited to legitimate use only and in many cases drugs not having addiction-producing properties could be substituted for those with addiction properties, the difficulty of controlling the production of addiction drugs and of handling the national and international problems attending them would be rendered easier.

The committee found, however, that in the United States few chemists were interested in the field of alkaloid chemistry nor had been, as evidenced in the literature, for over a period of twenty-five years. The committee was agreed that to find substitutes for addiction-producing drugs it would be necessary to set up a unit devoted to analytical and synthetic work in the field of alkaloid chemistry. It found that one man, Dr. L. F. Small, had just returned to the United States to the University of Virginia after having spent two years of research under Professor Wieland on alkaloid chemistry. The committee immediately entered into negotiations with President Alderman, of the University of Virginia, and Professor Benton, of the Department of Chemistry there, and, owing to their sympathetic cooperation, a laboratory for the study of alkaloid chemistry was organized at the University of Virginia with Dr. Small in charge. The committee hopes that this unit may develop into a permanent unit for the study of alkaloid chemistry in the United States.

This unit could be filled in two ways, either by

sending chemists to Europe to study or by bringing chemists to this country to the University of Virginia, there to place with them four or five chemists to be trained by them under Dr. Small's direction. The latter plan was adopted, and with the cooperation of the United States Department of Labor the National Research Council brought to the University of Virginia Dr. Mosett and Dr. Burger from the laboratory of Professor Spaeth in Vienna. Dr. Small, Dr. Mosett, Dr. Burger and four chemists have been working at the University of Virginia for the past eighteen months on the synthesis and degradation of phenanthrene derivatives producing compounds of increasing complexity which resemble this nucleus of the morphine molecule in physiological function and in degradation compounds of the morphine molecule itself.

In order, however, to know what effect these compounds would produce, whether of value or of no value as substitutes for addiction-producing drugs, it was necessary also to have a unit which could test these chemical products in a systematic way for their biological action. Through the sympathetic cooperation of President Ruthven and the trustees of the University of Michigan, such a unit was arranged for in the department of pharmacology under the supervision of Professor Edmunds and Dr. Eddy. As soon as the chemical products are manufactured at the University of Virginia they are sent, with a report of their chemical composition and properties, to the University of Michigan where they are studied biologically and then reported upon. Both sets of reports are studied by the committee and the value of the substances determined. Some thirty new compounds have already been made at the University of Virginia and sent to the University of Michigan.

For such a plan of work there were various phases requiring the help of the United States government. This help and cooperation was freely granted by the United States Public Health Service under the direction of Surgeon-General Cumming and by the Narcotics Bureau under Commissioner Anslinger. Also two manufacturing houses rendered help by contributing rare chemicals for this study. These firms are Merck and Co. and Sharp and Dohme.

Preparatory to the setting up of the two units mentioned, the committee found it necessary to provide an analysis of the chemical literature of the morphine derivatives for the use of American students, especially for the use of the students in the laboratory for alkaloid chemistry at the University of Virginia. Dr. Small has prepared this for publication and the United States Public Health Service has agreed to publish it as a bulletin. A similar analysis of the literature of the biological action of morphine derivatives is being prepared for the use of the laboratory at the University of Michigan by Dr. R. A. Hatcher, professor of pharmacology at Cornell University Medical School.

Such analyses are necessary in order that the group of workers in each university may proceed with their problems without the necessity of individually spending their time studying the literature.

The second avenue of approach adopted by the committee that might prove of some assistance in the problem of drug addiction was to present accurate information concerning the necessary uses for which addiction-producing drugs should be employed. The committee felt that if it could present these necessary uses to the medical profession, with suggestions for the substitution of non-addiction drugs in cases where the latter would serve equally well, the use of addiction-producing drugs might be considerably reduced. Articles to present this information are being prepared by the American Medical Association in conjunction with the National Research Council by Dr. Fishbein and a group of skilled writers to be published in the *Journal of the American Medical Association.*

Graduate students interested in alkaloid chemistry or the physiological action of alkaloids will find opportunity for such study at the University of Virginia and the University of Michigan.

WM. CHARLES WHITE,
Chairman, Committee on Drug Addiction

AMERICAN SCHOOL OF PREHISTORIC RESEARCH

THE tenth annual session of the American School of Prehistoric Research opened in Paris on July 1, and closed in Prague on September 3. Twelve students—ten men and two women—all but two of them graduate students, were enrolled: Lloyd Cabot Briggs, Harvard University; Miss Jeanne Ernst, Mount Holyoke College; John P. Gillin, University of Wisconsin; Robert F. Greenlee, Northwestern University; Theodore D. McCown, University of California; Robert H. Merrill, University of Michigan; John Z. Miller, Lehigh University; Panchanan Mitra, Yale and the University of Calcutta; Cornelius B. Osgood, University of Chicago; Froehlich G. Rainey, University of Illinois; Miss Lucile Serrem, Columbia University; Sol Tax, University of Wisconsin. J. Townsend Russell, Jr., a former student of the school, assisted the director, who also had the assistance of two other former students after the group reached Czechoslovakia, *viz.*, V. J. Fewkes, of the

University of Pennsylvania, and Robert W. Ehrich, of Harvard University.

The itinerary included parts of France, Spain, Switzerland, southern Germany and Czechoslovakia. Digging was done in three sites, representing various culture levels: thirteen days in the Abri des Merveilles (Dordogne), with three horizons—two Mousterian and one Aurignacian; three days in the cavern of El Pendo (Prov. Santander), Spain, with four horizons—Mousterian, Solutrean, Magdalenian and Azilian; and seven days at Homolka, near Prague, with late Neolithic and early metal cultures.

This gave the students a wide range of experience not only in the art of digging, but also practice in the determination of specimens from various epochs as well as from various phases of a given epoch. It was our good fortune at El Pendo to help in the discovery of two works of art dating from the Magdalenian Epoch—a stag engraved on bone and a horse, likewise engraved on bone.

The actual digging was supplemented by visits to fifty prehistoric sites representing practically every phase of prehistory and by the study of museum and private collections. Coincident with the diggings and the visits to sites and museums, forty-two conferences were given—eleven by the director and thirty-one by foreign specialists and by certain of the students. For these conferences we are indebted to the Abbé Breuil, Harper Kelley, Z. Le Rouzic, G. Chauvet, Étienne Patte, Count Begouen, Louis Begouen and D. Peyrony, in France; Carballo in Spain; D. Viollier and Emil Bächler in Switzerland; F. Birkner and K. Hörmann in Germany; and J. Schranil and J. Skutil in Czechoslovakia. The students who gave conferences were Greenlee, McCown, Merrill and Tax; a former student—Fewkes—also gave conferences.

Toward the end of the term, thanks to the assistance of Russell, Fewkes and Ehrich, it was possible for Mrs. MacCurdy and myself to remain behind in France in order to make a prehistoric pilgrimage through France and Spain with General Charles G. Dawes, our ambassador to Great Britain, who met us in Périgueux on August 23 and remained with us until the end of the month. At the same time there also joined our party Mr. Addison L. Green, chairman of our board of trustees, and his son, Marshall Green. We visited the principal prehistoric sites of the Vézère Valley; then went to northern Spain to see the cavern of Altamira and the prehistoric museum in Santander. In Madrid, we visited the Archeological Museum and the Museum of Natural History; and in Seville, the Archivo de Indias. From Seville, we made a two-day excursion to the museum at Niebla, the dolmen de Soto, and the prehistoric copper mines at Rio Tinto.

During the spring months our school dug jointly with the British School of Archaeology, Jerusalem, at the cave of the valley near Athlit, and south of Haifa, Palestine. This was our second season at this site. Miss Dorothy Garrod, representing the British school, was again in charge; our two representatives were Dr. Martha Hackett, of Mount Holyoke College, and Theodore D. McCown, of the University of California. This second season's excavations yielded some 20,000 specimens dating from the Mousterian, Aurignacian, Mesolithic and later epochs. Joint excavations will be resumed here during the spring of 1931.

In March, 1930, there was published *Bulletin* No. 6 of the School (43 pages), containing the director's report and Miss Dorothy Garrod's paper entitled: "The Paleolithic of Southern Kurdistan," which describes the joint explorations and excavations of our school and the Percy Sladen Fund (British) during the autumn of 1928.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

TWO IMPROVEMENTS IN THE TECHNIQUE OF KYMOGRAPH RECORDING

1. THE use of the pressure air gun for applying carbon particles in suspension in the place of smoking to blacken the recording surface.

2. The use of transparent cellophane in place of glazed paper as a recording surface.

(1) In many respects the time-honored procedure of preparing kymograph paper for use by "smoking" is a very unsatisfactory one. The unevenness of the resulting surface, particularly when natural gas is used in the smoking burner, the inconvenience in operation and smudginess of the smoking arrangements, and the inadaptability to other surfaces than glazed paper are perhaps the most serious difficulties. It has been found possible to obviate these and other difficulties by applying a suspension of fine carbon particles in a suitably volatile vehicle, sprayed on to the recording surface with an air gun. The following procedures have been found advisable in the preparation and application of the carbon suspension.

a The vehicle should be sufficiently volatile to just wet the surface slightly. If put on too dry the impact of the jet tends to remove some of the already

deposited particles. It must have a specific gravity approximating that of the carbon particles to be suspended in it in order to prevent rapid settling out. These requirements are rather well met by carbon tetrachloride. The cost of carbon tetrachloride being high, some of the heavier commercial hydrocarbons were used successfully, such as Union Oil Company's Cleaning Naphtha with a Baumé gravity of 55 and an initial and end boiling point of 95 to 145° C., respectively. Gasoline is not satisfactory, as the end point is too high.

b As a source of carbon particles of suitable size, the better brands of lamp black (vegetable black) have been found to be satisfactory. Some ten other kinds of black pigment were tried unsuccessfully. Sixteen grams of vegetable black per liter of fluid are taken, and the mixture shaken vigorously for five or ten minutes. This can be done most conveniently in a mechanical shaker. Grinding in a ball mill or deflocculating in a colloid mill would improve the suspension, but is not a necessity. The suspension is strained through as fine a mesh cloth as possible and stored in pint Mason jars, of the type fitting the pressure gun to be used. When the suspension is stored it must be shaken vigorously prior to use.

c In applying the suspension any well-designed spray gun in which the air issues from an annular orifice surrounding the fluid nozzle would probably be found satisfactory, but the cheaper makes of gun are to be avoided. We have used the "Sharpe" pint-size gun successfully at ten to twenty pounds air pressure. In applying the black it has been found advisable to rotate the drum rapidly on an upright shaft at a distance of 20 to 40 cm from the nozzle of the spray gun. At this distance the naphtha will not wet the surface of the drum excessively, providing the needle valve regulating the mixture of air and fluid is properly set. The spray gun should be shaken occasionally to prevent settling of the carbon. In this manner a thin, uniform coat of carbon particles can be applied quickly and conveniently to the recording surface. Too heavy a layer should be avoided in the interests of diminishing friction of recording levers and of preventing the washing of the carbon in the fixing process after records have been made. An enclosed exhaust booth is a necessity where a large amount of spraying is done. There is nothing critical in the above process and reasonable variations may be individually made.

(2) A very great simplification and improvement in the photographic reproduction of kymograph tracings has been found to be possible by the use of transparent recording material in place of glazed paper. The difficulties of photographic reproduction of varnished kymograph tracings are too well known, and too obvious from the many poor reproductions found in the scientific journals, to need emphasis. We have found it to be simple to avoid these difficulties by direct printing from fixed cellophane records. Colorless, transparent No. 600 cellophane sheets used in place of kymograph paper make a satisfactory recording surface. Celiophane can not conveniently be blackened by smoke and is best prepared for recording by the spray-gun method just described. After records have been made the surface can be fixed by passing the strip through a bath of carbon tetrachloride containing 3 per cent. rosin (the latter put into solution by prolonged mechanical shaking).

The record thus fixed can be used directly for printing positives, in which the graphic records stand out in black against a white background. Direct enlargements up to twenty times have been made retaining sharp delineation, and offer possibilities for closer study of certain phenomena (in our studies particularly isometric tension curves). Direct reduction is also highly successful and is desirable in printing upon lantern slides and in illustrations for publication.

It should also be noted that segments of the original fixed record can themselves be successfully used in making lantern slides by simple mounting between blank glass slides.

Transparent cellophane, No. 600, in strips 7 inches wide, rolled, has been supplied at our request by the E. I. du Pont de Nemours Company, and is priced at such a figure as to make its use more economical than that of glazed paper.

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C. H. THIENES
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USE OF ETHYLENE OXIDE FOR THE ERADICATION OF PESTS

THE barberry eradication campaign as well as the campaigns for the control of white pine blister rust through the eradication of currants and gooseberries have shown the need of a chemical substance with high toxicity to the plants, yet which will have no lasting detrimental effect on the soil. The practice of digging barberry bushes leaves a possibility of sprouts being produced from pieces of roots not found in digging. The use of common salt is a more desirable practice from the standpoint of the labor involved and the effectiveness of the killing agent. For use in pastures this method may have some objection. The use of chlorates, arsenates, etc., is excluded in pastures where cattle may be poisoned.

Some observations made by Vacha and Harvey[1] indicated a high toxicity of ethylene oxide to plant tissues. More recent work by the author has shown that ethylene oxide has many properties which make it suitable for killing noxious plants. By the use of a rod it can be introduced into the soil beneath the bushes. The "depth charge" can be regulated to certain levels of roots in the soil. The materials injected are not accessible to animals. Ethylene oxide is liquid at ordinary temperatures at pressures between eight and twenty pounds per square inch. This gives pressure sufficient to drive it into the soil directly from the tank. A special measuring device fitted to an injecting rod has been devised, which may be called a "gopher stick." Such a device is of use also in killing gophers by similar toxic agents. The ethylene oxide is volatile enough to allow a quick spread through the soil and a relatively short period of its effect in the soil. It is soluble in water, and dilutions with ice-cold water can be made with little loss when it is desired to use a water dilution or a mixture with other toxic agents. Dilutions can be handled in the usual knapsack sprayer with a "gopher stick" in place of the spray nozzle. Mixtures with chlorates or formaldehyde may be used without chemical reaction destroying the toxicity.

The ethylene oxide penetrates quickly up through the tissues, causing marked discoloration of the leaves within a few days. The effect in sterilizing the tissue through which it passes is being investigated since it may be of use in killing fungi or insects within the wood or bark to prevent their dissemination. The use of such a penetrating sterilizing agent would decrease the labor of removing trees which are infected with such pests.

The use of ethylene oxide alone and in water solution has been shown by the killing of several hundred bushes of barberry,[2] currant, gooseberry, poison ivy, prickly ash, scrub oak, popple, boxelder, etc. The size of the charge or dose must be adjusted to the bush to be eradicated. Determinations have been made on the charge required in different types of soils and with various soil moisture contents. Indications are that at the present price of ethylene oxide the cost of materials is about the same as for eradication by common salt while the labor is considerably reduced. Other oxides of the unsaturated hydrocarbon series are being tried for their toxicity and effectiveness.

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[1] *Plant Physiology*, 2: 187–193, 1927.

SPECIAL ARTICLES

THE BIOLOGY OF THE PETROLEUM FLY

RECENTLY a well-known systematic zoologist, Dr. W. T. Calman,[1] gently admonished physiologists for their tendency to neglect "the unending diversity of structure and habit among animals" and emphasized the danger of making far-reaching generalizations from experiments carried out upon the still somewhat restricted fauna of the physiological laboratory. In no group in the animal kingdom are such generalizations more unsafe than in the Insecta, for nowhere is physiological diversity more marked. And perhaps no insect is more aberrant physiologically than the petroleum fly.

Considering the fact that the existence of this insect has been known to entomologists for over thirty years, it might be thought that all the details of the life history and physiology would have been described long ago. Owing perhaps to the restricted distribution (it appears to be confined to the oil-fields of S. California) this is far from being the case, and although some of the main facts of its structure and life history have been described by Howard[2] and Crawford[3] there still remain many points of interest to be investigated. The subject is one of interest not only to the entomologist but also to the physical chemist and general physiologist, for, as is well known, paraffin hydrocarbons, owing to their power of rapidly penetrating cell membranes, are highly toxic to living tissues.

The writer had the opportunity while working at the Citrus Experiment Station of the University of California at Riverside in 1928 and 1929 of investigating certain matters concerning the nutrition of this insect and its adaptation to a life in oil. The main results of these investigations are here summarized. Full details of the experiments will be published shortly.[4]

The larvae of *Psilopa petrolii* go through their entire development in shallow pools of waste oil, breath-

[1] W. T. Calman, presidential address, Section D—Zoology, British Association for the Advancement of Science, 1930.

[2] The author is indebted to Dr. L. W. Melander and the Office of Barberry Eradication, U. S. Department of Agriculture, for cooperation and assistance in the experiments.

[2] L. O. Howard, *Scientific American*, 80: 75, 1899.

[3] D. L. Crawford, *Pomona College Journal of Entomology*, 4: 687–697, 1912.

[4] *Trans. Ent. Soc. Lond.*, 1930.

ing by means of the posterior spiracles which they can project above the surface of the oil at will, each spiracular process being supported by four fan-like structures which rest upon the surface film and which are closely similar to those found in many aquatic ephydrid larvae. The oil is the residue left when the more volatile elements, such as gasoline and petroleum naphtha, have evaporated off. Tests kindly carried out for me by Dr. R. H. Smith showed that at 310° C. only 10 per cent. of the oil had distilled over.

Howard[2] naturally assumed that the larvae must feed on the remains of insects or other organisms caught in the viscous oil, but some doubt was thrown on this by certain experiments carried out by Esterley and described by Crawford,[3] who reported that young larvae could be reared to maturity in filtered sterilized oil without any extraneous organic matter—the inference being that they could derive their energy from the digestion of hydrocarbons! The variety of digestive powers among the insects is well known, but such an astonishing conclusion as this seemed to demand further investigation.

By keeping the larvae in pure, transparent medicinal paraffin it was soon found that they readily devoured small pieces of animal tissue, and in this medium their exact method of doing so could easily be observed. But experiments were undertaken to test the matter further.

Sixty young larvae were placed singly in tubes each containing a small quantity of the natural oil which had been filtered through fine cloth by means of a suction pump. To thirty of these tubes was added every three days a small piece of a crushed tuber-moth larva, the larvae in the remaining tubes being starved. Of those which received food, 50 per cent. pupated and 33 per cent. emerged as adults, whereas none of the starved larvae lived to maturity. In another experiment in which 180 larvae were reared in filtered oil in petri dishes in lots of ten, the results were:

	Per cent. pupated	Per cent. emerged as adults
Oil alone	6.3	1.8
Oil plus food	53.0	41.4

and similar results were obtained from other experiments. It was found that the figures in the first line were due to the cannibalistic tendencies of these larvae when starved, those that die providing sufficient food material to bring a small percentage to maturity, and since details of Esterley's experiments have never been published and are not available, we must assume that this is the explanation of his results.

We may conclude then that the larvae can not develop without extraneous organic matter, and there is little doubt that under natural conditions small insects trapped in the sticky oil are the chief source of food. That they derive no nutriment at all from the oil is more difficult to prove, but experiments with a variety of oils of different composition gave no suggestion that they are able to do so. It was, however, interesting to find on sectioning that the hind gut contains enormous numbers of bacteria-like bodies. Without fresh material it is unfortunately not possible at present to identify them with certainty, but stained with Murray's toluidine blue—Van Gieson, they have the appearance of a coccobacillus. They are Gram-positive and approximately 1 μ in length, and are often present also in the mid gut within the peritrophic membrane, although always in much smaller numbers. What part, if any, these organisms may play in the processes of digestion it is at present impossible to say.

The Ephydridae is a group the larvae of which are characterized by ability to live in a variety of unusual situations—brine, alkaline waters, urine, etc. This ability appears to be due to the presence of a very impermeable cuticle and a very efficient mechanism of hairs and bristles protecting the spiracular openings. It is very largely by the same means, and *not* by any tolerance of the tissues themselves to hydrocarbons, that the petroleum fly is enabled to exist in its extraordinary environment. Experiments with various lighter and more volatile oils which are able to enter the tracheal tubes as vapor and condense as a film upon the walls, thus overcoming the protective mechanism, show clearly that when once the oil enters the tracheal system the toxic hydrocarbons are absorbed and, having got into contact with the tissues themselves, are as poisonous to the petroleum fly as to any other insect.

The impermeability of the general cuticle of the larva to substances usually regarded as highly penetrating is well shown by its resistance to fixatives; for instance, the larva will remain active in strong alcoholic picro-formol (Bouin's fluid) for twenty minutes. But why is it that the oil does not reach the tissues by absorption through the walls of the alimentary canal, which is filled with oil from end to end? The answer is that the oil never gets into contact with the gut epithelium at all. The fore and hind guts of course are protected by a chitinous layer, and in the mid gut there is the peritrophic membrane. The latter is well developed, as is the case with most cyclorrhaphous larvae, and from dissections it seems that the oil itself does not actually pass through the peritrophic membrane. The characteristic dark color of the oil is seen only within it, the region between the mem-

brane and the digestive epithelium, as well as the latter itself, being clear and unstained. Moreover, the wall of the mesenteron can be dissected away without difficulty, leaving intact the tough peritrophic membrane with its oily contents.

It might be thought that the water supply would be an acute problem for an animal living in such a medium, but this is not so, for distillation tests reveal that there is a considerable amount of water contained in the oil in the form of minute droplets, and, moreover, in many cases the oil pools overlie shallow pools of water, those most frequented by larvae being those in which there is no great depth of oil.

One would have imagined that an animal living in oil would be immune from the attacks of parasites, and it is interesting to find that a protozoan has been able to follow its host into such an environment. Certain of the epithelial cells of the mesenteron are seen in section to be distended with spores of a sporozoan parasite, apparently a microsporidian, the nucleus often being pushed to one side by the mass of spores. These bodies are approximately 4 μ in length and stain very intensely with toluidine blue, hematoxylin and methyl blue-eosin, the multinucleate nature of the spore being most clearly seen with the latter stain. Lack of material exhibiting further stages in the life history has so far prevented closer identification.

It is a remarkable thing that *P. petrolii* should exhibit no structural peculiarities correlated with its unique mode of life. With the possible exception of the unusually great muscular development which enables the larva to swim actively in such a viscous medium there are no *essential* morphological differences between the petroleum fly and a typical aquatic ephydrid. Such adaptations as must have occurred are physiological rather than morphological and are of a puzzling nature. What, for instance, can be the peculiarity about the spiracular structures which prevents the oil from spreading into them? Possibly the peristigmatic glands yield an aqueous secretion in place of the more general waxy or oily substances. Similarly, what substance can be produced by the glandular hairs of the tarsus of the adult fly which enables it to walk on oily surfaces which will entangle other insects almost immediately? Again what can be the change which must have taken place in the composition of the digestive juices to enable them to act upon food saturated with petroleum? These are the problems which concern the biochemist and the physical chemist rather than the entomologist, and appear to the writer to have a very considerable theoretical interest.

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THE MORPHOLOGICAL BASIS FOR CERTAIN TISSUE RESISTANCE

TISSUE resistance against bacterial invasion generally finds an explanation in the production of specific bactericidal and antitoxic substances on the part of the organism or in the increased activity of certain wandering cells of the infected host. The resistance which may develop in the higher animals against certain drugs and chemical poisons can not be explained by any of the above-mentioned mechanisms.

The fact has been known for many years that when either the acetate or the nitrate of uranium is given subcutaneously to dogs they develop an acute experimental nephritis in which the injury to the kidneys is at first, in so far as structural changes are concerned, very largely confined to the epithelium of the proximal convoluted tubules. Suzuki,[1] working in Aschoff's laboratory, was of the opinion that this acute injury was confined to the epithelium in certain segments of these tubules.

In a recent Harvey Lecture[2] and in two investigations[3,4] which formed the basis for the experimental data presented in this lecture, a discussion was undertaken of the toxic effect of uranium on the kidney and the mechanism of repair in the injured kidney, and certain observations were presented relative to the resistance which the kidney, the seat of a chronic uranium injury, developed against subsequent acute injuries from the same nephrotoxic substance.

During the past two years these studies have been continued by using repeated injections of uranium with the object in view of obtaining more evidence regarding the morphological changes developing in the kidneys which give to them both a structural and functional resistance to this poison. These experiments have been conducted by first anesthetizing normal dogs and removing from the left kidney a small wedge-shaped piece of tissue which, in its study, has served as the normal control for the acute and chronic changes developing in the kidneys fol-

[1] T. Suzuki, "Morphologie der Nierensekretion," Jena, 1912.

[2] Wm. deB. MacNider, "Urine Formation during the Acute and Chronic Nephritis Induced by Uranium Nitrate," *The Harvey Lectures*, 1928–1929.

[3] Wm. deB. MacNider, "The Development of the Chronic Nephritis Induced in the Dog by Uranium Nitrate. A Functional and Pathological Study with Observations on the Formation of Urine by the Altered Kidneys."

[4] Wm. deB. MacNider, "The Functional and Pathological Response of the Kidney in Dogs Subjected to a Second Subcutaneous Injection of Uranium Nitrate," *Jour. Exp. Med.*, XLIX, 411, 1929.

lowing a series of intoxications by uranium. Prior to such operative interference the functional value of the kidneys has been ascertained by the use of the phenolsulphonephthalein test for renal function, by determinations of blood urea, blood non-protein nitrogen and creatinine, and by estimating the reserve alkali of the blood. Following the subcutaneous injection of uranium in normal dogs and also in animals with a chronic renal injury from such injections, kidney tissue has been removed for microscopic study and observations have been made on renal function by the methods just indicated.

When a solution of uranium nitrate is given subcutaneously to dogs in the dose of from 2 to 4 mgs per kilogram the animals show an initial increase in the formation of urine, which is albuminous, a decrease in the elimination of phenolsulphonephthalein, a reduction in the reserve alkali of the blood, and a commencing retention of blood urea and non-protein nitrogen which is later followed by a retention of creatinine. Kidney tissue removed from such acutely nephritic animals has shown the characteristic uranium injury which anatomically is localized in the epithelium of the proximal convoluted tubules. The cells in this location have become edematous and vacuolated and have shown varying degrees of necrosis. The majority of animals with this type of acute renal injury effect either a partial or a complete functional recovery. On this basis they may be divided into two groups. In Group I, represented by animals with a return to a normal renal function, kidney tissue which has been removed has shown but slight evidence of injury to the vascular tissue of the organ. In the convoluted tubules, the seat of the initial selective epithelial injury, there has developed a process of repair consisting in a relining of these tubules by cells similar in configuration to those normally present in this portion of the tubule. These cells have their origin from convoluted tubule cells which have not been killed by the acute injury from uranium. When the animals of this group (Group I) that have effected a normal type of epithelial repair are given a second subcutaneous injection of uranium nitrate in an amount per kilogram similar to the first injection, they show no evidence of having acquired any tolerance or resistance in so far as the nephrotoxic action of the poison is concerned. This lack of protection in the kidney against uranium is indicated functionally by the development of a marked albuminuria, a reduction in the reserve alkali of the blood, a decrease in the elimination of phenolsulphonephthalein, and a retention of urea, non-protein nitrogen and creatinine. Animals of this group rarely survive a second injection of the poison. The histological study of renal tissue from such animals shows a repetition of the acute epithelial injury in the convoluted tubules. The regenerated cells of the normal type in this segment of the tubule become edematous and necrotic.

The animals falling in Group II are represented by those dogs which, after having developed an acute renal injury from the primary injection of uranium, failed to establish a complete restoration in renal function. They have shown such changes in the blood and urine with such pathological alterations in the kidneys as to enable them to be classified as animals with a chronic nephritis. The evidence of a partial restoration in renal function by the dogs of this group is found in the very greatly diminishing amount of albumin in the urine or its entire disappearance, by an increase in the ability of the kidney to eliminate phenolsulphonephthalein, by a return of the reserve alkali of the blood to the normal, and by a decrease in the retention of urea, non-protein nitrogen and creatinine. The histological study of renal tissue from the animals of this group, after they had established their functional pathological normal, shows that connective tissue changes varying in degree have taken place in the vascular tissue of the kidney. These changes are of the same type but are more advanced in their development than similar changes occurring in the animals of Group I. The striking difference which has taken place in the processes of repair in the kidneys of animals of Group II which separates them anatomically from the animals of Group I is to be found in the restoration of cells in the proximal convoluted tubules. The repair to the epithelial damage in these tubules has taken place by their relining with a type of cell morphologically different from normal proximal convoluted tubule epithelium and therefore different from the type of cell which was regenerated in these tubules in the animals of Group I. The repair process of the tubules in the animals of Group II which have failed to return to a functional normal has consisted in an ingrowth into the tubules of a flattened, non-specialized type of cell or by an ingrowth of an undifferentiated syncytial layer of cell substance containing large, deeply-staining nuclei. Mitotic figures are frequently found in either type of epithelial replacement.

The animals of Group II have been used for subsequent uranium injections, as was the case with the animals of Group I. When the animals of this latter group were given a secondary injection of 2 or 4 mgs of uranium per kilogram, they were found to have developed a definite resistance to its toxic effect in so far as this action was expressed by a functional renal disturbance. The amount of albumin appearing in

the urine was definitely less than that occurring from such secondary injections in the animals of Group I. The reduction in the elimination by the kidney of phenolsulphonephthalein was not so great, the reserve alkali of the blood was usually undisturbed, there was no retention of creatinine, and the retention of both urea and non-protein nitrogen was slight or failed to occur. In six dogs with a partial restoration in renal function from an initial uranium injection, the amount of uranium has been increased from the primary dose of 2 mgs per kilogram to 8 mgs and in each instance the same type of modified nephrotoxic action has been obtained.

The morphological basis for this resistance on the part of the kidney to uranium has been associated with the type of epithelial repair to the convoluted tubules and the extent to which this repair has taken place. Those animals with a chronic nephritis in which the epithelial replacement has been very largely effected by a relining of the tubules with a flattened, non-specialized type of cell, have shown functionally the highest tissue resistance against repeated intoxications by uranium. This type of cell is resistant to the toxic action of the poison. It fails under its influence to become edematous and necrotic.

These experiments would not indicate the acquisition on the part of the animals of an immunity to uranium, but the substitution in the kidney, as a result of a process of repair, of a type of epithelial tissue atypical for the convoluted tubules, which either fails to secrete uranium and subject itself to an injury from the substance, or an epithelium which is resistant to it during secretion. Such changes in cell types in the kidney may be looked upon as a morphological defense mechanism giving to the organ an acquired tissue resistance which varies in degree for subsequent injuries from the same chemical substance.

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A NEW FACTOR IN THE TRANSPORTATION AND DISTRIBUTION OF MARINE SEDIMENTS

ONE of the well-known facts concerning the distribution of marine sediments on the continental shelves is that there is a progressive gradation from coarse to fine-grained material away from the shore. The mechanism of the sorting power of the sea and its ability to transport material still remain an unsolved problem of the sedimentationist. Many explanations have been put forward as to the action of currents in the sea produced by tides, winds and differences in density, but no observational data have been accumulated to give us any definite knowledge of the method by which grains of sand and silt are actually transported. With the object of making an investigation of this subject, Mr. Stetson devised a trap which could be placed on the sea bottom in such a way as to catch particles which were traveling in suspension within a few inches of the sea floor. The traps are boxes of heavy galvanized sheet iron 1 foot 2 inches square in ground plan, with the sides bent in and sloping up to a central opening 8 inches square. In some cases the trap was constructed with the lip 1 inch from the bottom, in other instances 6 inches. The deeper traps seem on the whole to be the more satisfactory. Two half doors hinged in the middle were fitted to the opening, which could be tightly closed by a messenger dropped from the surface before the apparatus was hauled up. It is planned to place a series of these traps along a profile on the continental shelf, with the hope of obtaining from them some knowledge of when, and possibly how, the grains travel.

Among the first results of the preliminary work with the traps has been to find, on hauling the first of them after it had been a week on the bottom in about eight fathoms of water, approximately a half mile east of the sandy bluff known at Fourth Cliff, Scituate, that it contained a layer 2 inches deep of a jelly-like substance concerning which little or nothing seems to be known. This jelly is practically colorless, and, when examined under the microscope, also structureless. In it are found grains of sand and silt, fragments of eel grass and fucus, much macerated particles of various algae, shells of diatoms and foraminifera, and small spicules of various sorts. The origin and composition of the jelly are a subject for investigations which are now being carried out. The late C. G. Joh. Petersen investigated the organic matter in the waters off Denmark, and found at the bottom a layer from one to three mm in thickness, composed largely of organic matter, which on account of its color he called the brown layer. He also found in certain localities what he spoke of as mud which quivered like jelly. The material he found seems to have been very much like the jelly in our trap. Petersen's studies, summarized in the report of the Danish Biological Station, Vol. XX, 1911, led him to the conclusion that the material with which he was dealing was made up principally of decomposed vegetable matter, the chief contributor being eel grass. Another suggestion is that the material might be sewage, but it is seemingly too abundant and too widely distributed to be so explained.

A survey of the distribution of this material has been carried on, using a scraper dredge. Several lines of stations were run, beginning at the beach and going off shore about ten miles, with bottom samples taken about every mile. The places selected were the south

shore of Massachusetts Bay from Marshfield to Cohasset, and the southern half of Ipswich Bay north of Cape Ann, because in both these regions the profile of equilibrium appears to be well developed. The jelly was found in every haul and on every sort of bottom. In the shoal water near shore, 20–150 feet deep, much fresh material is present, that is, the plant fragments are still identifiable. The entangled sand grains here range as high as fine beach sizes. The mud zone on the Massachusetts coast begins at a depth of about 225–300 feet. From a depth of 200 feet outward, the jelly was a homogeneous mass in which the organic detritus can not be identified. Some of the fresher material taken near shore was allowed to stand about four months in sealed jars. At the end of that time, the plant fragments had rotted down so that the jelly resembled that found in the mud zone. The sediment collected at 350 feet of depth, which was the deepest taken, ranges from clay and silt sizes to very fine sand. A bottom core, five feet long, taken at this depth in Ipswich Bay, shows about 10 per cent. fine white sand, and the rest clay and silt. It is homogeneous in composition for its whole length.

As might be expected, there seems to be a definite relationship between rough and calm weather and the condition of the jelly. During periods of calm the very top of the jelly layer flocculates and collects in light feathery masses. After a period of rough weather the entire layer is churned up and samples taken at such a time present on settling a much more uniform and compact appearance. Further settling of the very fine particles again produces the flocculent appearance of the top layer. This condition may be duplicated by violent agitation in a jar in the laboratory.

The transporting power of this jelly is further illustrated by the fact that during and after every storm it may be taken, with its entangled sand, from surface water. The roiling, so noticeable in coastal waters after every storm, is probably due in a large measure to this jelly and not to free sediment. The day after a 60-mile easterly gale, three gallons of surface water were taken off the entrance to Cohasset harbor in 25 feet of water. This position is protected from the full sweep of the seas by a string of ledges a mile or more off shore. After filtering and washing with fresh water, the sample was ignited to remove the organic material. .2604 gram of actual sand and silt remained. The largest sizes are included in Wentworth's "very fine sand" class with sizes ranging from 1/8–1/16 mm. These grains are largely quartz. It is obvious that if this amount of sediment was in suspension at the surface, greater quantities would be encountered near the bottom. The total carrying capacity must be enormous. This may explain in a large measure the rapid silting of harbors and estuaries; it enables sediment to travel along the bottom and in suspension in a current the velocity of which would otherwise be powerless to move it. On the day in question the flood tide entering Cohasset harbor was so muddy with jelly that an object two feet below the surface was invisible. The ebb was noticeably clearer.

The main significance of this material, whatever may be its origin, lies in its obvious importance as an agent in the transportation of sand grains. Samples of the material dried and weighed after the combustion of the organic matter shows that about 85 per cent. by weight consists of grains of various sizes, from fine sand to silt. Since only the slightest amount of current is necessary to transport this jelly, it could be widely and easily distributed without evoking the aid of any strong currents near the sea bottom.

If Petersen is correct in his contention that most of the organic matter in the coastal waters is decomposed eel grass, then there is a periodicity in transportation. Eel grass being a deciduous plant, the new supply of vegetation is an annual product, the decay beginning with the shedding of the leaves in the fall. The thin brown layer which Petersen found in large areas of the sea bottom around Denmark is believed to be decomposed eel grass which had come to rest below the wave base. It is, therefore, possible that since heavy storms are likewise seasonal, the jelly may have another significance in that it may possibly form parting planes, and in some places at least may happen to be buried and produce the appearance of varves, which is not infrequently observed in marine strata. It seems more probable that eel grass is only one of its constituents and that algae probably play a large part. The chemical analysis is now being carried out, and next summer a survey of its distribution will be made in the Gulf of Maine and adjacent waters.

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